Report and Proceedings

OF THE

BELFAST

NATURAL HISTORY & PHILOSOPHICAL SOCIETY

FOR THE

SESSION 1890-91.

~~WITH SUPPLEMENT CONTAINING CATALOGUE OF BOOKS IN THE SOCIETY'S LIBRARY.~~

BELFAST:
PRINTED BY ALEXR. MAYNE & BOYD, 2 CORPORATION STREET
(PRINTERS TO THE QUEEN'S COLLEGE.)

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CONTENTS.

Belfast Natural History and Philosophical Society.

ESTABLISHED 1821.

SHAREHOLDERS.

1 Share in the Society costs £7.
2 Shares ,, ,, cost £14.
3 Shares ,, ,, cost £21.

The proprietor of 1 Share pays 10s. per annum ; the proprietor of 2 Shares pays 5s. per annum ; the proprietor of 3 or more Shares stands exempt from further payment.

Shareholders only are eligible for election on the Council of Management.

MEMBERS.

There are two classes—Ordinary Members, who are expected to read papers, and Visiting Members, who, by joining under the latter title, are understood to intimate that they do not wish to read papers. The Session for Lectures extends from November in one year till May in the succeeding one. Members, Ordinary or Visiting, pay £1 1s. per annum, due 1st November in each year.

Each Shareholder and Member has the right of personal attendance at all meetings of the Society, and of admitting a friend thereto ; also of access to the Museum and Library for himself and family, with the privilege of granting admission orders for inspecting the collections to any friend not residing in Belfast.

Any further information can be obtained by application to the Secretary. It is requested that all accounts due by the Society be sent to the Treasurer.

The Museum, College Square North, is open daily from 10 till 4 o'clock. Admission for Strangers, 6d. each. The Curator is in constant attendance, and will take charge of any Donation kindly left for the Museum or Library.

Belfast Natural History and Philosophical Society.

ANNUAL REPORT, 1891.

The Annual Meeting of the Shareholders in this Society was held on 20th June, 1891, in the Museum. Amongst those present were the Rev. John Kinghan, Professor Fitzgerald, C.E.; Dr. MacCormac, Messrs. R. Lloyd Patterson, J.P., F.L.S. ; John Anderson, J.P. ; J. J. Murphy, James Thompson, J.P. ; Robert Young, C.E. ; A. T. Jackson, John Brown, Wm. Swanston, F.G.S. ; R. Ll. Praeger, M.R.I.A. ; James O'Neill, M.A. ; and R. M. Young, B.A., *Hon. Secretary.*

On the motion of Mr. James O'Neill, the chair was taken by Professor Fitzgerald.

Mr. R. M. Young, *Hon. Secretary*, read the Annual Report, which was as follows :—

"The Council of the Belfast Natural History and Philosophical Society appointed by the Shareholders at the last Annual Meeting on 23rd May, 1890, desire to submit their Report of the working of the Society during the past year.

"The ordinary Winter Session was opened on 10th October, 1890, when an Address was delivered by the Right Hon. Leonard H. Courtney, M.P., on 'Proportional Representation,' illustrated by a test election.

"The second meeting was held on 3rd November, 1890, when Mr. George Trobridge, head-master of the Belfast Government School of Art, gave a lecture on 'Art in the Belfast Museum.'

"The third meeting was held on the 2nd December, 1890, when two papers were read; one by Mr. R. W. Murray, J.P., on 'Eighteen Months in the Confederate Army,' and the other by Mr. E. N. MacIlwaine, on 'Queensland and the Bush.'

"The fourth meeting was held on 6th January, 1891, when a discussion took place on the subject of a tunnel between Ireland and Scotland, opened by Mr. L. L. Macassey, B.L., C.E., followed by Messrs. F W. M'Cullough, C.E.; J. Maxton, J. C. Bretland, M.I.C.E, city surveyor; Conway Scott, C.E.; Professor Fitzgerald, C.E.; Sir W. Quartus Ewart, Bart.; E. N. MacIlwaine, J. Brown, Professor Everett, F.R.S.; and the President.

"The fifth meeting was held on 3rd February, 1891, when Mr. Alex. Tate, C.E., gave his report as the Society's delegate to the last meeting of the British Association, and Mr. Howard T. Sinclair, M.D., read a paper on 'Some Modern Advances in Medical Science—Micro-organisms and their Relation to Disease,' illustrated by micro-photographs of bacilli, &c.

"The sixth meeting was held on 3rd March, 1891, when three papers were read—Mr. William Workman, on 'Heating and Ventilating,' illustrated by diagrams; Mr. P. E. Gulbransen, on 'Some Practical Difficulties about Pendulums, and How to Overcome Them,' illustrated by a barometrical pendulum; and Mr. Robert Young, C.E., on 'Some Notes on the Geology of the Excavations for the Main Drainage Work.'

"The seventh meeting was held on the 7th April, 1891, when a lecture was delivered by Mr. Talbot B. Reed, on 'The First Printers,' illustrated by early printed books, illuminated MSS., &c.

"These meetings were well attended, both by the members and the general public, the lecture hall being inconveniently filled on some occasions. As other kindred Societies had early in the season arranged for several courses of popular lectures, your Council considered it prudent to suspend their usual series, with the intention, however, of resuming them next session.

With this end in view they have made a provisional arrangement with Professor G. Stokes, T.C.D., who has kindly consented to deliver a lecture next session.

"It will be observed from the Hon. Treasurer's Statement of Accounts that he is able to show a substantial balance after discharging all liabilities. This is the more satisfactory as your Council have carried out several much-needed improvements, involving an expenditure of over £50. These include the fitting-up of the lecture room with ventilating gas-lights in the ceiling, and new seats, which have given much satisfaction. A large book-case has also been added to the library. The Annual Report has been much enlarged, as some of the papers were considered of sufficient interest to be given *in extenso.* The number of Societies meeting in the Museum shows no diminution, and the improved accommodation provided will doubtless lead to its more extended use.

"The collections were, as usual, opened to the public at a nominal charge on Easter Monday and Tuesday. Several friends, including Messrs. W. Swanston, F.G.S., and Seaton F. Milligan, M.R.I.A., lent valuable objects, which, with the numerous recent donations, attracted a large number of visitors.

"Your Council have proceeded to carry out the wishes of the Shareholders, as conveyed in the resolution unanimously passed at the Special General Meeting of the Society convened for the purpose on 19th March last, viz.:—'That the Council be authorised to proceed with the obtaining of a constitution for the Society from the Educational Endowment Commissioners on the basis of the draft submitted, or any amendments or additions thereto that may be found desirable.' They have now received the draft scheme from Dublin, and with a few amendments it is submitted for your consideration.

"As the amount of work to be done at the Museum has much increased, largely owing to the additional meetings held during the session, it has been considered necessary to appoint an assistant to Mr. Stewart, who is thus enabled to take up

more fully the scientific portion of his duties. Your senior curator, Mr. William Darragh, owing to his advanced age, is in feeble health, and your Council, in consideration of his faithful services for so many years, have arranged, subject to your approval, to grant him a retiring allowance of £48 per annum, with the condition that Mr. Darragh shall vacate the house. A special meeting, convened according to the rules, will be held immediately after this meeting for the purpose of deciding on this proposal.

"The Ulster Fauna Committee, which was referred to in last report as having been recently appointed 'to supplement the work so ably prosecuted by the late William Thompson,' has been actively engaged, through its joint Secretaries, Messrs. Robert Patterson and R. Lloyd Praeger, B.E., M.R.I.A., in collecting and tabulating the information available for the purpose from the numerous observers now in correspondence with them throughout Ulster, a report of which is hereto appended. A list of the donations to the Museum and of publications received from home and foreign Societies with which we are in correspondence will be printed with the present Report. Amongst the donations may be specially mentioned a large collection of South African bird skins, comprising many rare specimens, presented by Mr. George Gordon, Strandtown, and some fine Burmese objects, the gift of Captain J. Gillman. In this connection the Council would desire to give their best thanks to the local Press for their admirable reports of the Society's proceedings."

Mr. R. Lloyd Praeger, B.E., M.R.I.A., submitted the Report of the Secretaries of the Ulster Fauna Committee, as follows :—

"It being now a year and a half since the Ulster Fauna Committee, of which Mr. Robert Patterson and myself have the honour of being Secretaries, was appointed by the Council

of the Society, the time has come when it is right that we should lay before the members a short report on the progress made during that time as regards our inquiry into the nature and distribution of the Vertebrate Fauna of the Province. Much time has been occupied in enlisting the services of competent observers in various parts of Ulster. The result has been on the whole satisfactory, as we have now a body of 51 observers scattered through Ulster. Large districts are, however, still unrepresented, as the following list will show :—County Donegal, 10 observers ; County Londonderry, 6 observers ; County Antrim, 12 observers ; County Down, 11 observers ; County Armagh, 5 observers ; County Tyrone, 4 observers ; County Monaghan, 1 observer ; County Fermanagh, 2 observers ; County Cavan, 0 observer—total, 51. From this it will be seen that, while the North-Eastern counties are being fairly well worked, the number of observers in Monaghan, Fermanagh, and Cavan especially, is much below what is desired, and we trust that by next year these deficiences may be filled up. With a view of systematising the information obtained from our observers we have issued a number of schedules, copies of which we submit herewith. These have proved decidedly successful in extracting general information. Up to the present, forty-one have been returned to us duly filled, and a large number still remain in the hands of observers. In addition to these, correspondence on many special points is being constantly carried on, and we may mention that up to the present date 304 letters have been written and 270 received. In the present incomplete state of our work, which indeed is only commencing, it is undesirable that we should attempt to enter into particulars as regards the information already collected, but we venture to believe that the foregoing statement will satisfy the Society that we are endeavouring to carry out the work towards the accomplishment of which we applied for their assistance."

The Financial statement showed a balance of £28 odd in the hands of the Treasurer.

Dr. MacCormac, in moving the adoption of the Report, said he did so with genuine pleasure, because the Report proves that the Society is successfully holding on its way. Its membership has increased during the year, its pecuniary condition is favourable, and the Museum has been enriched by valuable specimens during the past twelve months. This he would say, that the prosperity is very much owing to the ability of the Hon. Secretary, Mr. Young, and to the favourable notices of the work of the Society by the Belfast Press, which tend to interest the people in scientific studies. Belfast is taking a prominent lead in the acquisition of material things, and she feels she will not be satisfied until she does the same scientifically. He had much pleasure in moving the adoption of what all must feel to be a very satisfactory Report.

Mr. A. T. Jackson seconded the motion.

The Chairman said the work of the Ulster Fauna Committee has taken a considerable amount of labour, and he thought the special thanks of the meeting should be given to that Committee for the trouble they have taken and the labour they had gone through in carrying out that work, which appears to be progressive, and which he was sure would produce useful results.

Mr. R. L. Patterson desired to say a few words about the Report, which he thought was a good one, and one of which the governing body had every reason to be satisfied. He concurred with the mover of the resolution with regard to the thanks due by the Society to their Hon. Secretary, and proceeded :—There are one or two matters in the Report as to the presentations to the Society which call for more than passing mention. We see before us a very interesting and valuable collection of birds from South Africa, which has been presented to the Museum by Mr. George Gordon. A cursory glance at the birds cannot fail to strike anyone with the curious resemblance on the one hand and the differences on the other that they present to the birds which we see on any day of the year. Another interesting and valuable addition to theMuseum consists

of two bronze Japanese plaques, the gift of the late Mr. Henry Matier, who has been a patron and friend of the Society by presenting to it art of the highest class, far beyond the means of the Society to procure in any other way. I cannot but say that the Society has lost in Mr. Matier a valuable and esteemed friend. Our collection has also been enriched by a number of interesting works from Burmah, which have been presented to us by Captain Gillman. Such men as he can do much for this Museum if when they are in distant lands they remember that there is such a receptacle for such objects of interest.

The Report was adopted.

On the motion of Mr. PATTERSON, seconded by Mr. JOHN KINGHAN, the thanks of the Society were given to the donors mentioned in the Report.

The HON. SECRETARY said it was intended to ask the Sanitary Institute of Great Britain to hold their Annual Meeting in 1892 in Belfast, and Mr. Macassey was of opinion that the Society should on that occasion pass a resolution agreeing to assist the Institute in every way in its power. The Institute is second only to the British Association, and we are not as far ahead in Belfast in sanitary science as in other branches of science.

The CHAIRMAN said :—It would be well, as Mr. Macassey has not been able to attend, to adopt a resolution on the subject. The Mayor takes a great interest in the Institute, and I am sure its visit to Belfast will be a very successful and profitable one. I have therefore great pleasure in moving—"That this Society is glad to hear that the Sanitary Institute of Great Britain is likely to visit Belfast next year, and that it will in every way in its power contribute to the success of the meeting."

Mr. ROBERT YOUNG seconded the motion, which was passed.

This concluded the ordinary business, and the meeting was afterwards made special for the purpose of considering and, if approved, of sanctioning the granting of a retiring allowance to Mr. William Darragh, senior curator, and of considering the

draft constitution of the Educational Endowment Commissioners as amended by the Council.

Mr. THOMPSON moved that a retiring allowance of £48 per annum be granted to Mr. Darragh as a recognition of his long and faithful service to the Society. He said :—It was, as I am informed, my brother William Thompson that was the means of Mr. Darragh's first connection with that Museum. I have seen much of him for a good many years past, and when he severs his connection with that institution we shall miss an old and valued friend.

Mr. PATTERSON said :—It is with somewhat mixed feelings I second the motion. While I regret that the time and circumstances render it necessary that the connection which has so long existed between Mr. Darragh and themselves should be severed, I am satisfied that the Society is in such a pecuniary position as to justify it in taking the step proposed. The motion comes with singular appropriateness from Mr. Thompson, the brother of William Thompson, whose name lives in every book on ornithology published within the last fifty years ; and it is not inappropriate that I should second the motion, in view of the fact that my father, with the late Mr. William Thompson, was one of the seven founders of the Society, and was long connected with Mr. Darragh during the period of forty-seven years he had charge of the institution. That was a long period of service. I have known Mr. Darragh since I was seven years of age, and to know him was to appreciate and esteem him. I think we shall all agree that the time has arrived when he should be relieved from active duties.

The CHAIRMAN endorsed the remarks as to Mr. Darragh's long and useful connection with the Society.

The motion was passed unanimously.

The meeting then took up the consideration of the draft constitution of the Educational Endowment Commissioners as amended by the Council in reference to the Society ; and, after some discussion, it was adopted, on the motion of Mr. ANDERSON, seconded by the Rev. JOHN KINGHAN.

The new Council held a meeting at the conclusion of the proceedings, when the following office-bearers were elected for the year 1891-92 :—President, Professor M. F. Fitzgerald, M.I.M.E. ; Vice-Presidents, Messrs. John Brown, William Swanston, F.G.S. ; Joseph Wright, F.G.S. ; R. M. Young, B.A., F.R.S.A.I. ; Hon. Librarian, Mr. T. Workman, J.P. ; Hon. Treasurer, Mr. John Brown ; Hon. Secretary, Mr. R. M. Young, B.A., C.E. A large number of interesting donations to the Museum were also received.

The Belfast Natural History and Philosophical Society in Account with Hon. Treasurer

Dr. For the Year ending April 30th, 1891. **Cr.**

EXPENDITURE.

		£	s.	d.
To Cash paid	Insurance Premiums	£6	12	0
,,	Printing Report	28	13	6
,,	Printing, Stationery, and Bookbinding	9	15	8
,,	Advertising	14	12	0
,,	Collector's Commission	6	8	4
,,	Water Rate	2	4	7
,,	Fuel and Gas	20	12	11
,,	Carriage, Postage, Telegrams, &c.	6	2	6
,,	Purchase of Shares Bought in	5	0	6
,,	Expenses at Easter	9	3	2
,,	Repairs	8	11	0
,,	Bookcase and Case for Emu	19	5	0
,,	Seats for Lecture Room, Chairs, &c.	20	8	0
,,	Carpet	4	0	0
,,	New Gas Fittings and Ventilators in Lecture Room	13	3	9
,,	Wm. Darragh, Salary till April 30th	48	0	0
,,	S. A. Stewart, ,, ,, less one week's leave	49	0	0
,,	S. A. Stewart, Gratuity	10	0	0
,,	W. Miller, 18 weeks' Salary till April 30th	6	15	0
,,	J. Green, Reporting Discussions	3	4	6
,,	Rent till April 30th	25	0	0
To Balance		28	2	5
		£344	14	10

RECEIPTS.

		£	s.	d.
By	Balance in Hon. Treasurer's hands	£63	11	4
,,	Interest on Deposit with York St. Spinning Co.	19	10	1
,,	Transfer Fees	0	11	0
,,	Donations	17	19	0
,,	Subscriptions	134	14	0
,,	Do. in Arrear	0	10	0
,,	Proceeds of 1 Bookcase sold	2	0	0
,,	Entrance Fees at Door till April 30th	22	17	0
,,	Do. Easter Monday	32	19	3
,,	Do. Easter Tuesday	4	6	2
,,	Contribution from Beekeepers' Association, 1889-90	1	4	6
,,	Do. Naturalists' Field Club	8	8	0
,,	Do. Dr. Whitla	1	8	6
,,	Do. Ulster Medical Society	16	1	0
,,	Do. Ulster Amateur Photo. Society	3	15	0
,,	Do. Society for Extension of University Teaching	15	0	0
		£344	14	10
By	Balance in Hon. Treasurer's hands	£28	2	5

Examined and found correct.

June 8th, 1891.

Wm. H. Patterson, } *Auditors.*
Wm. Swanston. }

J. Brown, *Hon. Treasurer.*

DONATIONS TO THE MUSEUM, 1890-91.

From Miss Duffin, Strandtown.

An egg of the Rhea (South American Ostrich).

From John S. Thompson, Esq., Glassdrummond, Co. Down.

A stuffed specimen of the nightjar (*Caprimulgus europæus*) shot on Spence's Mountain.

From J. M. Barnett, Esq., M.D.

An iron coffin guard dug up at Clifton Street Cemetery.

From Mr. Charles Bulla.

A number of fossil palates and other fish remains from the Carboniferous rocks at Armagh.

From Thomas Workman, Esq., J.P.

A number of South American insects.

From Mr. John Howat, Glasgow.

A specimen of Boulingite and other minerals from Scotland.

From A. M'D. Calwell, Esq.

An emperor moth (*Saturnia pavonia*) caught near Larne.

From Mr. Herbert Pearce.

A butterfly from the south of Europe.

From John Brown, Esq.

A mackerel encircled with an elastic band which had tightened on the growing fish, and cut into its flesh. It was taken with the hook near Annalong.

From Alfred Jaffe, Esq., J.P.

A hank of New Zealand flax, and specimens of siliceous sinter from New Zealand.

From A Friend.

A volume of specimens of British seaweeds.

From R. Lloyd Praeger, Esq., M.R.I.A.

Three specimens of the burrowing sea-urchin (*Echinus lividus*) from Bundoran.

From Mrs. S. J. Moore, Elmwood Avenue.

A prayer book printed in 1710.

From Dr. M'Cleery.

A human skeleton.

From W. H. Patterson, Esq., M.R.I.A.

Several flint flakes from the lower bed of the Larne gravels.

From the late H. Matier, Esq., J.P., Dunlambert.

Two bronze Japanese plaques mounted on polished teak stands.

From Miss Sydney M. Thompson, Macedon, Belfast.

Specimen of *Oldhamia* from the Cambrian rocks of Bray.

From Wm. M'Cammond, Esq., J.P., Brookvale Terrace, Duncairn Street.

Three pieces of ancient wooden water-pipes dug up at Donegall Place.

From Dr. J. King Kerr, The Knock.

A specimen of the glass rope sponge (*Euplectella*) from Manilla.

From Seaton F. Milligan, Esq., M.R.I.A.

Two pieces of ancient wooden water pipes dug up in Castle Street, Belfast.

From the Rev. S. A. Brenan, B.A., Cushendun.

A collection of Irish Coleoptera.

From The British Museum, per Dr. G. Jeffreys Bell, F.L.S.

A large number of specimens of *Echinodermata*, many of which represent important genera.

From the Rev. Mr. M'Kee.

A Malayan Manuscript.

From Captain J. Gillman.

Idols from Burmah, viz., three marble figures of Brama, and a Ballan or evil spirit carved in wood.

From George Gordon, Esq., Strandtown.

A large number of rare bird skins from South Africa.

ADDITIONS TO THE LIBRARY, 1st MAY, 1890, TILL 1st MAY, 1891.

ADELAIDE.—Transactions of the Royal Society of South Australia. Vol. 13, parts 1 and 2, 1890.
From the Society.

BELFAST.—Proceedings of the Belfast Naturalists' Field Club. Vol. 3, part III., 1890. *The Club.*

Catalogue of Early Belfast Printed Books, 1890.
The Belfast Library and Society for Promoting Knowledge.

BERGEN.—Bergens Museums Aarsberetning, 1889.
The Museum.

BERLIN.—Verhandlungen der Gesellschaft für Erdkunde zu Berlin. Vol. 17, parts 4-10; and vol. 18, parts 1 and 2, 1891. *The Society.*

BIRMINGHAM.—Proceedings of the Birmingham Philosophical Society. Vol. 7, part 1, 1889-90.
The Society.

BOSTON, U.S.A.—Proceedings of the Boston Society of Natural History. Vol. 24, parts 1 and 2, 1889; and parts 3 and 4, 1890. *The Society.*

BREMEN.—Abhandlungen herausgegeben vom Naturwissenschaftlichen Vereine zu Bremen. Vol. II., part 2, 1890.

Festschrift zur feier des funfundzwanzigjahrigen Bestehens des Naturwissenschaftlichen Vereins zu Bremen. Vol. II., part 1, 1889.
The Society.

BRESLAU.—Zeitschrift fur Entomologie herausgegeben vom Verein fur Schlesiche Insektenkunde zu Breslau. Neue folge funfzehntes heft, 1890.
The Society.

BRIGHTON.—Annual Reports of the Brighton and Sussex Natural History and Philosophical Society, 1888, 1889, and 1890. *The Society.*

BRUSSELS.—Tables Generales du Bulletin de la Société Botanique de Belgique, 1890. *The Society*

Comptes Rendus de la Société Entomologique de Belgique. Vol. 34, seances Feby.—Sept., 1890. *The Society.*

Annales de la Société Malacologique de Belgique. Vol. 24. Proces Verbaux des Seances. Vol. 19, parts 1-8, and parts 10-16, 1890. *The Society.*

CALCUTTA.—Memoirs of the Geological Survey of India. Vol. 24, part 2, 1890. Records of the Survey. Vol. 23, parts 2-4. *The Director of the Survey.*

CAMBRIDGE.—Proceedings of the Cambridge Philosophical Society. Vol. 7, part 3, 1890. *The Society.*

CAMBRIDGE, U.S.A.—Bulletin of the Museum of Comparative Zoology. Vol. 16, Nos. 8 and 9; vol. 19, Nos. 3 and 4; and vol. 20, Nos. 1-8, 1890; also Annual Report for 1889-90. *The Curator.*

CARDIFF.—Report and Transactions of the Cardiff Naturalists' Society. Vol. 21, part 2; and vol. 22, part 1, 1889-90. *The Society.*

CHERBOURG.—Memoires de la Société de Sciences Naturelles et Mathematiques de Cherbourg. Vol. 26, 1889. *The Society.*

CHRISTIANIA.—Christiania Videnskabs Selskabs Forhandlinger. Nos. 1-12, 1889. Oversigt, 1889; and Universitats Programm für 1890. *The University.*

DANTZIC.—Schriften der Naturforschenden Gesellschaft in Danzig. Neue folge siebenten bandes, drittes heft, 1890. *The Society.*

DUBLIN.—Scientific Proceedings of the Royal Dublin Society, N.S., vol 6, parts 7-9, 1890. *The Society.*

Catalogue of the Vertebrate Animals in the Science and Art Museum, Dublin.
The Curator, Nat. History Department.

EDINBURGH.—Laboratory Reports of the Royal College of Physicians, Edinburgh. Vol. 3. 1891.
The College.

Proceedings of the Royal Society of Edinburgh. Vol. 15, 1889; and vol. 16, 1891.
The Society.

Proceedings of the Royal Physical Society. Vol. 10, part 2, 1891. *The Society.*

EMDEN.—Jahresbericht der Naturforschenden Gesellschaft in Emden, 1888-9. *The Society.*

ESSEX.—The Essex Naturalist and Journal of the Essex Field Club. Vol. 3, Nos. 10-12, 1889; and vol. 4, Nos. 1-12, 1890. *The Club.*

FLORENCE.—Bulletino della Societa Entomologica Italiana. Parts 3 and 4, 1889; and parts 1-4, 1890.
The Society.

GENOA.—Ateneo Ligure Rassegna Mensile della Societa di Letture e Conversazioni Scientifiche di Genova. Anno 13, 4 parts, 1890; and anno 14, 1 part.
The Society.

GIESSEN.—Siebenundzwanzigster Bericht der Oberhessischen Gesellschaft für Natur-und Heilkunde, 1890.
The Society.

GLASGOW.—Proceedings of the Philosophical Society of Glasgow. Vol. 21, 1890. *The Society.*

HALIFAX.—Proceedings and Transactions of the Nova Scotian Institute of Natural Science. Vol. 7, part 3, 1890. *The Institute.*

IGLO (Austria-Hungary).—Jahrbuch des Ungarischen Karpathen-Vereines, 17th year, 1890.
The Society.

KHARKOW.—Travaux de la section Medicale de la Société des Sciences Experimentales. Three parts, 1889.
The University.

KOLOZVART (Transylvania).—Maygar Novenytani Lapok (Hungarian Journal of Botany). Vol. 13 and Appendix, 1890. *The Publisher.*

LA PLATA (Province of Buenos Aires).—Le Musée de La Plata; Rapide Coup D'Œil sur sa fondation et son Developpment; also "Revista Argentina de Historia Natural." Vol. 1, parts 1 and 2, 1891. *The Director of the Museum.*

LAUSANNE.—Bulletin de la Société Vaudoise des Sciences Naturelles. Vol. 25, No. 101, 1890; and vol. 26, No. 102, 1891. *The Society.*

LEIPSIC.—Mitteilungen des Vereins für Erdkunde zu Leipzig, 1889. *The Society.*

LONDON.—Memoirs of the Royal Astronomical Society. Vol. 49, part 2, 1887-9. *The Society.*

Proceedings of the Geologists' Association. Vol. II., No. 5, 1889. *The Association.*

Quarterly Journal of the Geological Society. Vol. 46, parts 2-4, 1890; and vol. 47, parts 1 and 2, 1891 *The Society.*

Journal of the Royal Microscopical Society. Parts 3-6, 1890; and parts 1 and 2, 1891. *The Society.*

Proceedings of the Zoological Society of London. Parts 1-4, 1890. *The Society.*

MADISON, U.S.A.—Transactions of the Wisconsin Academy of Sciences, Arts, and Letters. Vol. 7, 1889. *The Academy.*

MADRAS.—Catalogue of the Batrachia, Salentia, and Apoda of Southern India; also Notes on the Pearl and Chank Fisheries of the Gulf of Manaar. *The Superintendent of the Central Museum, Madras.*

MANCHESTER.—Transactions of the Manchester Geological Society. Vol. 20, parts 18-21, 1890; and vol. 21, parts 2-6, 1891. *The Society.*

MELBOURNE.—Transactions of the Royal Society of Victoria. Vol. 1, part 2, 1889.

Proceedings. New series, vol. 2, 1890.

The Society.

Second Systematic Census of Australian Plants, by Baron Ferdinand Von Mueller, K.C.M.G., F.G.S., F.L.S., etc. *The Author.*

MEXICO.—Anuario del Observatorio Astronomica Nacional de Tacubaya. Ano 11, 1890; and Boletin, vol. 1, Nos. 1 and 2. *The Director.*

Memorias y Revista de la Sociedad Cientifica "Antonia Alzate." Vol. 4, Nos. 1-4.

The Society.

NEW YORK.—Bulletin of the American Geographical Society. Vol. 22, Nos. 2-4, and Supplement, 1890; and vol. 23, No. 1, 1891. *The Society.*

Annals of the New York Academy of Sciences. Vol. 4, No. 12, and vol. 5, Nos. 1-8, 1889.

Proceedings, part 2, 1890. *The Academy.*

NEWCASTLE-ON-TYNE.—Report of the British Association for the year 1889. *The Association.*

ODESSA.—Memoirs of the Society of Naturalists of New Russia Vol. 14, part 1, and vol. 15, parts 1 and 2, 1889-90. *The Society.*

OSNABRUCK.—Jahresbericht des Naturwissenschaftlichen Vereins zu Osnabruck, for years 1889-90.

The Society.

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Dr. De Toni, Proprietor and Editor.

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BELFAST
NATURAL HISTORY & PHILOSOPHICAL SOCIETY
SESSION 1890-91.

10th October, 1890.

J. H. Greenhill, Esq., Mus. Bac., in the Chair.

The Right Hon. Leonard H. Courtney, M.P., delivered an Address on

PROPORTIONAL REPRESENTATION.

The subject on which I have to address you is one which some would describe as a hobby of mine, others as a fad ; and certainly it is one upon which I am easily led to talk. The question I have to bring before you is a question of what some would call political machinery. We have got a work to do, and how can that work be secured ? If I can impress you in any degree with my own ideas, I shall lead you at the end to regard it not so much as a matter of political machinery as a matter of political physiology ; for we are not dealing with a manipulation of inanimate units, mere rods, or molecules of matter ; we are dealing with human beings, whose wills have to be expressed, and whose resolution has to be determined, whose minds have to be measured, and whose desires have in some measure to be reflected. More than that, we are dealing with human beings upon whose individual activity, upon whose energy and whose life what some would regard as the dead machinery of which we are talking might have the most vital and stimulating influence. It is one of the essential questions of modern life to know how to carry out that great idea of constructing a representative body that shall represent the will and secure the desire of the

persons who have the privilege of electing that representative body. Wherever modern civilisation extends, wherever there is an enfranchised community, wherever there is a body of certain persons who have the privilege of electing the governing assembly of a community, we are concerned with the question of how that governing assembly should be elected, and the first thing we have to secure is this, that the governing assembly should at least represent the will of the persons who have the privilege of electing. That is essential. If we go through the process of electing a body and the body elected does not represent the determination of the will of the community, we have failed in the very first thing we meant to secure.

It is of no use for a hundred thousand persons to go through any process of election, if, in the end, the body they elect has a will one way, and the opinions of the hundred thousand persons go the other way. Let us suppose the election of one person by, say a hundred thousand persons, as they do by a plebiscite in France and in America, where they elect a President. A bare majority of the hundred thousand voters elects a President, and he, when elected, may be held to express the determination of the will of the majority of the electorate ; but, of course, he does so temporarily only ; there can be no certainty that he will continue to represent the community, and he only does so in the sense of representing the balance of their opinion. Sometimes it has been held that in the election of one man they do secure what is wanted. They secure, no doubt, for that one moment, but not for any time to be measured afterwards, the expression of the determination of the popular will.

Another method which has been proposed is this : Suppose a hundred thousand persons have to elect a hundred persons as their representatives. Let each one of the hundred thousand vote for a hundred persons. Now, you might suppose that never could be proposed as a practical suggestion ; but it was once carried out in one of our Australian

colonies—South Australia—the Legislative Assembly being elected by one vote of the whole community. But even then they would not necessarily secure for any time to come—say for three or four years—a body whose opinions would represent the continued determination of the electorate upon the issues that might arise. Supposing those hundred thousand persons vote, and a hundred persons are elected by the votes of sixty thousand going for them, while forty thousand go for an opposition which does not get elected at all, their hundred elected would be elected by sixty thousand out of the hundred thousand. After a year or two some question arises which splits up the hundred elected, and they divide themselves into sixty on one side and forty on another ; the sixty who form the majority of the hundred evidently will not be entitled to say that they represent the sixty thousand who elected the whole of them. They can only say they represent the six-tenths of the sixty thousand—in other words, thirty-six thousand. Twenty-four thousand out of those who voted for them may rightly claim to be represented by the minority in that assembly. Therefore, we have got on the issue so presented, that, after the first year or two, the balance in the elected assembly only represent thirty-six out of the original hundred thousand—in other words, a minority. That process absolutely fails in securing for the assembly the primary characteristic of being from time to time a trustworthy and faithful representation of the opinions of the majority of the electorate.

What we mean when we talk of representative government is the securing of an assembly in which there shall be at least people representing both sides on the great questions occupying popular attention—an assembly where somebody shall be able to speak in opposition to, as well as somebody in favour of, the opinions of the majority—where there shall be the power of getting heard what can be said against a proposition as well as what can be said in favour of a proposition ; and if we do not send to the elected body, in the first place, representatives of both sides, we have a body

wanting in the knowledge which is necessary for considering political problems from time to time, because it only represents one side ; wanting the thought that is necessary, because it only represents one form of thought ; wanting in the experience which is necessary, because it only represents one form of experience.

When we, from our historical past, and from our knowledge of the present, speak of representative Government and what we desire thereby, we mean that in the assembly to which is to be entrusted the power of choosing the Government and controlling and directing it, there ought to be found a representation not merely of the dominant side in the electorate, but of all sides :—not only of two sides, but of all possible sides that can be found in the electorate:—so that in the elected assembly we may, if possible, obtain a representation as faithful as it can be of the shades of opinion amongst the electing persons—not merely, to use the popular language, that there should be Tories and Whigs or Conservatives and Radicals, but that there may be those go-betweens who go from one to the other, who ought to be reflected in the political body, if the political body is to have within it those elements of knowledge and experience and of thought which are necessary for the right formation of opinion.

I believe we all instinctively feel that if we are going to elect a representative at all, and if we are going to fulfil the idea of representative government, we must have in our representative assembly some representation, not merely of the majority of the community, but of the minority also. Supposing we want to get in a representative assembly representatives of two sides, how shall we do it? The popular answer for a long time has been—and the popular answer at this moment is—this : suppose we have got a hundred persons to be elected and a hundred thousand to elect them :—we distribute the electors locally into districts, each containing as nearly as possible a thousand persons, and let each thousand elect by a majority the person who is to represent that district. We thus

get from the hundred districts a hundred persons, each person representing the majority in the district, and the hundred persons so elected may be taken as representing the fair divisions of opinion and the fair divisions of knowledge and experience and political thought amongst the whole electorate. That is the popular answer. I have to submit to you the truth, that you do not secure this conclusion. You may obtain it, but you have no security that you will, and in many cases you certainly will not.

Consider the case of five divisions, and a thousand persons in each division. Each division is to elect one out of five persons. The principles upon which the older reformers used to rely was that the minority of the five divisions would always correspond to the minority of the five thousand electors. I venture to say there is no such security. Take the divisions, call them A, B, C, D, and E, and call the two parties X and Y. In Division A let the thousand be divided in the proportion 550 for X and 450 for Y, which gives a majority for X of 100, and let it be the same in the case of B and C. Well, now, in D it may happen that there is a considerable difference, and the party in favour of X is only 400, while those in favour of Y are 600 strong, and in the case of E let the same rule obtain. Now the result will be that X gets 2,450 votes with three members, and Y gets 2,550 votes with two members. If you have followed my illustration in detail, you will have seen that although the electors are divided into five equal divisions, with a thousand in each, the result of the distribution of the parties is such that the party Y, which has a majority of the whole, has only two members, and the party which has the minority has three members. That is a proof that the system of dividing the electorate in equal bodies with equal members in each, and giving each the right to elect one member, does not secure the condition that the balance of influence or opinion in the elected chamber should correspond with the balance of opinion in the electorate, which is the first great thing to be attained. But this is not done. Now, this is not an extraordinary hypothesis, and if some person

should suppose it is not realized in practice, I have to tell him it was realised in the last election of five members for a populous English town—it does not matter what is its name, or whether it is Liberal, Conservative, or Radical, but the minority of voters returned three members out of five. Well, if you give the matter a little consideration you will see that it depends upon the fact that in the districts D and E there is a great congestion of the party Y. The balance was heavier for Y in these two districts than for X in the districts of A, B, and C, and if clever people got these districts into their hands, and knew that the party they did not like was strongly congested in one corner, they might cut up the area so as to make that party throw away their power in such a manner that they could not make any practical use of it.

What happened by a mere accident in this English constituency has happened over and over again by design in many of the American States, and has received the special name of jerrymandering. Those astute persons are said to jerrymander who so divide a State that they can carry a majority of the elections, although they have only a minority of the electors. This has been done repeatedly in the United States, and it appears to be done elsewhere, because the last revolution in the canton of Ticino was due to the fact that, although one party of the electors were in power numerically, they never could secure a majority of votes in the Canton or Chamber. Now, this will prove to you that the very first condition or requisite of a representative Government—namely, that the balance of the chamber should correspond, in the beginning at least, to the balance of the electorate—is not necessarily fulfilled by dividing up the area into districts containing equal numbers of electors, in which a member is returned for each district.

It may also fail in many other ways. In addition to the United States and Ticino I may refer to other illustrations, which may be present in the mind of some of you, where a minority has been entirely effaced, and got nothing whatever

in the representation to which, according to the principles of representative government, it was entitled. I might go on further, but I have shown these great faults in the present system. There are yet two or three faults to which I must ask your attention. If you divide up your electing body in this way into divisions, each containing an equal quota—say a thousand—and give to the majority in each thousand the right to elect a member, you can only present to that constituency one choice. The choice is a candidate belonging to party X or to party Y. If there are other candidates, they have no chance of being chosen, and the candidates have to adjust their expressions of opinion, so as to secure support. After speaking of the difficulty of finding a good representative under this system, the lecturer said :—At present we have got a method which gives us no security in the first place that the legislative assembly will reflect the balance of opinion of the electorate. It may even cut the other way. It may, and probably will, if it gives any representation of the minority, give that representation in a very insufficient form. It fails altogether to give all the shades of opinion which are to be found within the two political parties, and which are still more to be found in the case of the people at large. It constitutes an assembly such as has been described with truth as a very bad school for sincerity. Cannot we get into it a faithful copy not only of the party on one side and the party on the other, but also of the intermediate parties? That is the question which we have been asking, and it is the answer to that question which some of us believe has been discovered when we use the words "Proportional Representation." We are desirous of bringing into the electoral assembly a representation, in due and exact proportion as far as human institutions will permit, of all the political elements which exist among the persons who elect to that assembly, and by the very act of putting them there the people will give life and hope to others who have hitherto held back and not taken part in political life in the constituencies, and will give them the means of maintaining their hope and their energy in the future.

But how is it to be done? You have got 5,000 to elect five persons. Instead of dividing your 5,000 persons locally into a thousand each inhabiting its district—1st, 2nd, 3rd, 4th, and 5th—and saying to the thousand in district A, ' You elect a man by your majority," and to the thousand in B district, " You elect a man by the majority," and so on, we say to the 5,000, " If any one thousand can choose a man that one thousand shall have a member." All the 5,000 will thus get an actual representative in the five. Any one of the 5,000 will be able to say, "I have got my member there." The three who form a majority of the five must necessarily correspond to the 3,000 forming a majority of the 5,000. You secure in your elected body a representation of all the electors. Everybody is brought into vital union with the elected body, and you secure a faithful representation of the division of the electors. The member will not be dependent for re-election upon the necessity of getting a majority of votes in the restricted number of 1,000 to vote for him; he will secure his election if he can draw together any 1,000 who will continue to vote for him; and, although he may lose some voters here, he will gain some voters there, and he will have the confidence of not being any longer tied and bound by the conditions of party adherence. He may, by the force of his own vitality, virtue, and character, bring together whenever a re-election came another 1,000. I need not point out what an enormous difference this would have upon the character of men in the House of Commons, and upon the character of the men who have to send men to the House of Commons.

I have dropped for the first time the words House of Commons, and I apologize, because we are speaking in the air—we were speaking of legislative assemblies. We may see how powerful independent thought would be within the legislative assembly, and how powerful independent action would be, if a person so acting were aware that there were many without who corresponded with his thoughts and who vibrated to his action, whose will and feelings and impulses marched with his own, and that he was

certain of being re-elected when the time of election came. It is no great insult to those who may chance to be members of legislative assemblies to say that they have to observe and rule their conduct according to those conditions which prevail during their election. The conditions which now prevail are often unfriendly to the cultivation of the best qualities of statesmanship. The conditions which, under the plan now suggested to you, might be found to prevail, would be such as would strengthen them and tend to improve them ; and the *morale* of all the elections would be of a good and strengthening character instead of tending to their deterioration and degradation. How can this be achieved ? Can we have a system by which, if 5,000 persons have to elect five members, we can enable them to group themselves together so as to return persons they may choose—1,000 voting for A, 1,000 for B, 1,000 for C, and so on ? I believe that can be done, and done most easily, and I propose to exhibit in actual form how it can be done. The problem which I am going to put before you is something rather smaller than that—it is the election of three persons.

The right hon. gentleman then proceeded to conduct a test election. Printed voting papers were distributed among the audience. The following was the

VOTING PAPER.

THREE MEMBERS TO BE ELECTED.

	Order of Preference.
DUFFERIN, LORD	
HUXLEY, T. H.	
M'CARTHY, JUSTIN, M.P.	
SPENCER, HERBERT	
TENNYSON, LORD	
TYNDALL, JOHN	

INSTRUCTIONS TO VOTERS.

1. Each voter has one vote.

2. The voter is to put on the right-hand side, opposite the names of the candidates, the numbers 1, 2, 3, and so on, in order of his preference for them.

3. His vote will be given to the candidate against whose name he puts the figure 1, unless that candidate have enough votes to secure his election, when it will be given to the candidate who has the figure 2 against his name; or, if he have enough, to the candidate who has the figure 3 against his name, and so on.

4. It is not necessary to put numbers against all the names.

5. The same number must not be put against more than one name.

The lecturer explained that the test election was not a political one, but that votes were expected to be given upon literary distinction. The voting papers having been marked, collected, and counted, it appeared that 196 persons had voted. The right hon. gentleman said:—The first thing to be done is to ascertain how many votes are necessary to bring a candidate in. That I have not explained. There are three to be elected, and you may think that one-third of 196 is the necessary number —65 and a fraction. That is not the case. Divide 196 by 4—that is one more than the number to be elected—and the quotient will be 49. If anybody gets one vote more than that—*i.e.*, 50—that person is sure to be elected, and for this reason. If out of 196—those who have voted—you deduct 50, there will only be 146. The number 146 is less than three times 50. It is impossible to distribute it amongst three, each of whom would be above the man who has got 50. Inasmuch as one man has got 50, three other persons cannot be above him, and therefore he is certain to be elected. In other words, if the number of persons to be elected is three, the necessary number to bring a person in is the total number who have voted divided by four, plus one, which divisor is one more than the number to be elected. If

four were to be elected the number required would be the total number of voters divided by five, plus one, and so on. The calculation is a simple arithmetical one, and would have to be done by the returning officer and his clerks. The lecturer then stated that there had been four spoiled votes. One voter had so evenly a balanced mind that he had put "1" after three names; he wanted three persons to have first place. Another more remarkable one still was where a voter had marked a name 2, another 3, another 4, but had omitted to mark "1." These spoiled votes reduce the papers to 192, and the qualifying number to 49.

The persons who had been marked "1" were then written upon the blackboard as follows :—

Lord Dufferin	113
Professor Huxley	1
Mr. Justin M'Carthy	13
Mr. Herbert Spencer	9
Lord Tennyson	37
Professor Tyndall	1

The lecturer said :—Lord Dufferin is duly elected, but his Lordship only required 49 votes, whereas he has 113 papers. He has, therefore, got a surplus of 64. We must take away, therefore, 64 from his heap of 113. The question arises, which 64? Experience shows that it does not matter—the result in the end will be practically the same. The 64 papers were then taken from Lord Dufferin's "heap" and distributed with the heaps indicated by the figure "2" placed upon them by the voter. The result was that 7 votes were added to Professor Huxley, 2 to Mr. M'Carthy, 1 to Mr. Spencer, 26 to Lord Tennyson, and 28 to Professor Tyndall. The right hon. gentleman said :—

Lord Tennyson is in. He has got 63. He only, however, wanted 49, so we will take from his heap 14, and add them to the names marked "3." The result is that Mr. Huxley gets 1 vote more, Mr. M'Carthy 2, Mr. Spencer 2, and Professor Tyndall 9 more. That brings Professor Tyndall above the

quota, and we have now got the three persons who represent the tastes of this audience—Lord Dufferin, Lord Tennyson, and Professor Tyndall. I think you will see that the process is one of extreme simplicity, and that the counting is an easy matter. I claim that it is of infinite worth, because it enables every element in the electoral body to find its counterpart in the elected body. It gives an opportunity to every element to exercise a really valid choice. It is not merely "One man one vote," but "One man one share in the person elected." No person's power is necessarily thrown away; every one is kindred with the nation, and in living active vital union with the legislative assembly. The man so chosen does not know the persons who have chosen him. They may be spread over a considerable space. But he knows that he has been selected out of a crowd of candidates, and that he is entitled to go on in the strength and fulness of that persuasion, and he will know and believe that if he maintains in the future the qualities which attracted support to him in the past, he will go in again and again, and we shall get in our legislative assembly stability and freedom, a real representation of the people, and, at the same time, real strength of character on the part of those elected. This will make the nation itself nobler, by kindling within it, in every part of it, a true political feeling and true political aspirations, and we shall make the assembly a real flower of the nation, to which all best qualities will go, while there will be, not merely improvement and excellence of the persons elected, but a development of the nation which will result in its continued prosperity, its continued progress under an All-Seeing Creator.

On the motion of Mr. Adam Duffin, President of the Belfast Chamber of Commerce, seconded by Mr. James Musgrave, J.P., Chairman of the Belfast Harbour Commissioners, a cordial vote of thanks was passed to Mr. Courtney.

The right hon. gentleman having replied,

Miss Todd moved a vote of thanks to the President.

Dr. Hyndman seconded the motion, which was adopted.

The Chairman acknowledged the compliment, and the proceedings terminated.

NOTE BY THE LECTURER TO THE FOREGOING ADDRESS.

It has been suggested that the selection of Lord Dufferin's surplus votes for distribution involves the element of chance. No voter will know for whom his vote will tell, and the other candidates may be favoured or injured according to the set of surplus votes that may be selected.

The voter, at all events, can scarcely complain. If his paper remains one of these securing Lord Dufferin's election, his first desire is fulfilled with his assistance; if it is passed over as he has directed, it is because his first desire is fulfilled without his assistance, and his contingent order is obeyed.

But a candidate may be pushed forward or put back. In the test election in the text no manipulation could have produced any other result than the election of Lord Tennyson and Professor Tyndall; but it is conceivable that when *the number of votes given is very small and the motives of second choice very independent*, manipulation might modify the order of a return. As numbers increase, variations in the distribution of second votes diminish; so that if out of a heap of 5,000 papers a surplus of a 1,000 had to be taken, it would not matter whether this 1,000 was taken from the top, the bottom, the middle, or in any other fanciful way; the 1,000 would be found distributed in the same proportions, with very narrow limits of variation. This is more and more the case when the election is a real act of political or social life, and the surplus votes of the prime favourite of a party become apportionable among second favourites with the regularity of a fixed law. The element of chance disappears; and it may be noted that even if it could remain potent, it would only affect the question which of two members supported by persons of primarily the same way of thinking should be preferred to the other.

3rd November, 1890.

J. H. Greenhill, Esq., Mus. Bac., in the Chair.

George Trobridge, Esq., Head Master of the Belfast Government School of Art, read a Paper on

ART IN THE BELFAST MUSEUM.

Museums are generally voted dull places, and the Belfast Museum has, I fear, with the outside public the reputation of being the dullest of dull Museums. I do not think the Museum deserves quite all the abuse it receives, though it is not as cheerful a place as it might be. I must confess I have found a great deal to interest me in it, and so, I think, most persons would if they knew what to look for. Why is it that museums are found dull ? For the same reason that many interesting books are dull to a large class of persons. They are not educated to appreciate them, or they have dissipated their powers by over-indulgence in light literature. A museum, though dedicated to the muses, is not a place of amusement in the common sense of the term ; it is essentially a place of study. We must remember that the muses presided over history and astronomy as well as over music and dancing. A museum is dull to the ignorant, but a heaven of delight to the learned. What we want in order to make museums interesting is a guide, and, without pretending to deep knowledge either in art or antiquity, I humbly offer my services in that capacity while we explore some of the dark corners of the Belfast Museum.

In looking round to find material and illustration for my lecture, my most important and extensive discoveries were in

the department of ceramic art. My remarks will therefore chiefly have reference to that, the oldest of arts, and to illustrate them I have made a selection of objects of different periods and styles, from the wares of ancient Greece to those of our own country and the nineteenth century. It is well understood that we in this nineteenth century are immensely superior to all pre-existent persons in our manufacturing resources, in power over the material and forces of nature, in science and in industrial art. At any rate, that is a very general impression. Can it be that as the result of all our increased facilities and opportunities, we are producing nothing worthy of preservation to hand down as models and examples to our descendants, who may not be as clever as ourselves? Why do not our museums contain more specimens of the "highest excellence"? Instead of setting before students examples of modern manufacture, the authorities of our museums collect and display everything that is not modern, and even the productions of semi-barbarians, and our art instructors continually point to those as our very best models. Far from the history of ceramic art showing unbroken progress, the productions of recent centuries exhibit continual and rapid decline, and the lowest point of depravity was reached in the middle of this boasted and conceited century. Of the examples to which I desire to draw your attention this night the best are the very oldest, and all that have any pretension to beauty or excellence are either old or barbaric. We are only beginning to discover our deficiencies and to remedy them by recourse to the study of such examples. The very stimulus to that study came in great measure from a people who had been regarded at the time as little better than savages —our Indian fellow-subjects. The Indian section in the Great Exhibition of 1851 was a revelation to all who had eyes to see, and shamed our own productions of industrial art into utter worthlessness. In skill of workmanship, in beauty of form and general design, and in harmony of colour there is no comparison possible between the refined productions of the East and our own crude and garish manufactures. How comes it, then, that

comparatively untutored people have reached a point of excellence in industrial art to which we cannot attain with all our educational appliances and unlimited resources of production ?

To answer that question fully would require more time than we have at our disposal this evening. One important reason is that we have become so accustomed to ugliness in all our surroundings that we have lost the instinctive sense of art common to most unsophisticated peoples. We tolerate things in our houses and buildings and in our streets which would have been unendurable for a single moment to the ancient Greeks. Then our artists have been taught to look to precedents, and to copy the works of bygone styles so slavishly that they have almost ceased to attempt originality. We are happily beginning to see our error in that respect, and the five orders are no longer held to embrace the whole of architecture, but there is still much in our methods of art study that tends to the same contracted ideas. Another and perhaps the greatest drawback to our success in industrial art is to be found in our modern method of mechanical production and the excessive division of labour. Works of art cannot be produced by the gross. To be worthy of our regard they must bear the impress of the individual mind. Even if we were to try to reproduce in quantity some of the beautiful forms before us, we should find our reproductions insipid and uninteresting ; there would be all the difference between the two that there is between an original painting and a chromo-lithograph.

Mr. Trobridge then contrasted the methods adopted by our modern manufacturers of textile and other wares with those which result in the production of such things as we think worthy to be placed in our museums, and proceeded :—

In the first place, the modern manufacturer, so called—that is, the proprietor of the works or factory—cares nothing for art. What he wants is something that will sell. If the public demand bad art, he is quite content they should have it ; if high art is the rage, he will exert himself to produce it for us as long as it pays. Of course I shall be met with the remark

that we cannot return to the primitive ways of semi-civilised nations ; but the fact remains that we cannot have art like theirs, which we all admire, without adopting something of their ways. Beautiful things can only be produced in a natural way by persons living in the midst of beauty and open to the inspirations of nature. The circumstances of our artisans unhappily exhibit the very reverse of these conditions :—our manufacturing towns for the most part are dirty, ugly, and uninteresting. Such inspiration as our designers get has to be found in other ways, chiefly by studying, and more or less laboriously copying, the works of former artists. In the words of William Morris, who has done more than most to renovate industrial art in our day, "art which is to be made by the people and for the people is a happiness to the maker and the user." Not much of our modern art (I am speaking of objects of everyday use) is a joy to the user, and still less, I fear, brings happiness to the producer. The art that we want is that, to quote the words of Mr. Morris again, which "will make our streets as beautiful as the woods, as elevating as the mountain sides, so that it will be a pleasure and a rest, and not a weight upon the spirits, to come from the open country into the town ; every man's house will be fair and decent, soothing to his mind and helpful to his work ; all the works of man that we live amongst and handle will be in harmony with nature, will be reasonable and beautiful." We are a long way from realising this desirable condition of life at present, but we are making some feeble steps towards it. An increasing number of persons take a sincere delight in things of beauty, and there is a feeling abroad that what is good for the educated and appreciative minority is good also for the less favoured masses. Our Kyrle Societies, art schools, associations, &c., are all in some degree paving the way for a wider and healthier appreciation of art. I may add that there is an extensive and unoccupied field for our operations in our own city, which, whatever it may be in respect to learning, is not an Athens in its patronage and appreciation of art.

Mr. Trobridge then described a number of objects of ancient art which are in the Museum collection, and contrasted them, particularly as regards form, with several of modern style, pointing out that while many of the former are of rude workmanship, they all possess some element of beauty, which, though it has not been sought as an end, has been achieved naturally, and we may almost say inevitably.

Mr. ROBERT YOUNG, sen., moved a cordial vote of thanks to Mr. Trobridge for his excellent paper.

Mr. GRAY, in seconding the motion, said the Government School of Art was not at all in keeping with the size and importance of Belfast, and he trusted that the public of this city would fully realise the great importance of such an institution, and support Mr. Trobridge and his excellent staff of teachers.

Mr. SWANSTON, in supporting the motion, regretted the absence in the Museum of samples of textile fabrics.

The motion was passed by acclamation, and,

Mr. TROBRIDGE having acknowledged the compliment, the proceedings terminated.

2nd December, 1890.

J. H. Greenhill, Esq , Mus. Bac., in the Chair.

R. W. Murray, Esq., J.P., read a Paper on

EIGHTEEN MONTHS IN THE CONFEDERATE ARMY.

The Southern States of America at the time of the Civil War, though determined to maintain slavery, were not fighting for it, as it had not been attacked, but for what they regarded as their rights under the Constitution. I presume most of my audience are aware of the fact that I am a Virginian by birth. Circumstances occurred in 1855 which changed my residence from America to this country, and with the expectation of making it my permanent home I lived in Belfast until 1860. Cogent reasons then existed for my return to the States, and, having decided on Norfolk, Virginia, as my future home, I returned to America in 1860, when not only the whole country was intensely excited by the Presidential campaign, then being hotly conducted, but anxiety was pictured in every face, as it was felt the only possible result was the election of Mr. Lincoln, the consequence of which was not difficult to foresee. I remained quietly in Norfolk, a loyal citizen of the United States, until the battle of Fort Sumpter, which followed the secession of the seven cotton States from the Union, when Mr. Lincoln issued his famous proclamation calling upon Virginia and all other States in the Union to furnish their contingent of men to subdue the rebellion. Neutrality then became a crime, and Virginia had to decide whether to take her place by the side of her natural allies and fight for or against the corner-stone of the United States Constitution—viz., "State

rights," a principle she had successfully contended for on the first formation of the Union, and which had ever since continued the creed of the dominant political party. Her action was not doubtful, and, foreseeing that all intercourse with the outer world must soon close, I hurried North in April, 1861, with the object of arranging some private business before all communication was suspended. I was, however, only permitted to proceed to Baltimore. On the night of April 20th the great arsenal of Norfolk was evacuated, when nine ships of war were destroyed to prevent them falling into Confederate hands. This great Confederate success was achieved by the strategy of a Virginian citizen soldier and the bravery of three companies of Virginian volunteers. Troops from the South soon afterwards came in force, and a few days placed Norfolk in such a state of defence that the fears of the most timid were set at rest. The action of the Federal Government had now only effectually crushed out the last lingering attachment of Virginia to the Union, and, having decided to join the Confederate Army, I spent a few months at the University, Virginia, where a school for drill had been established, and a course of lectures on the science of war was delivered by a French ex-officer. A few months after the battle of Bull Run I entered the Confederate service as a private in a Norfolk company which had existed long before the war, and had formed one of three companies that had relieved the Federal Government of the Norfolk arsenal. It offered also this inducement, that it was composed almost exclusively of gentlemen. For some months we were encamped in the neighbourhood of Norfolk, Virginia. By far the most interesting event of my garrison life was the witnessing of the greatest naval engagement of the war between the Confederate ram "Merrimack" and the first Federal "Monitor." Shortly after this the term of enlistment of most of the Confederate army expired, and it had of necessity to be reorganised. I had been then offered a captaincy of a company, but, shrinking from the responsibility, I declined it for a first lieutenancy. I found subsequently, however, that I enjoyed all the responsi-

bility of captain, but with only the rank and pay of first lieutenant, my captain being only present in our first engagement.

Mr. Murray then described the first battle in which he took part, an engagement before Richmond between the Federal General MacLellan and General Lee, who commanded the Confederate forces ;—and continued :—If I must honestly confess my own feelings, I had never any desire for a first engagement. The more I heard of the whistling of the bullets the more I became convinced that Charles XII. was a madman.

The Confederate soldiers were miserably armed at the time, particularly those regiments that had manned the heavy batteries around Norfolk, conspicuously among which was my own company. On inspection it was found that they were so miserably equipped that the option was given of remaining in camp. We had certainly never contemplated meeting an enemy with such weapons, but while I suspected that many shared my own feelings, I was sure that not one of us would have lagged behind, even though we had been asked without arms to act as a target for the enemy's shot. We, however, were placed in the rear as a reserve, and during the whole of the day the battle of Fair Oaks or Seven Pines raged in our front. About sunset our regiment was ordered forward, and we for the first time came under fire when it was too late to continue the contest. We bivouacked on the field, but all night long our rest was broken by the shrieks of the wounded and the twinkling lights of the ambulance corps. So sudden had the call been made upon us, that we had neither haversacks nor provisions, and we had to satisfy the cravings of nature by collecting biscuits from the haversacks of the dead which lay thickly scattered about us.

Mr. Murray, proceeding, gave an account of the other battles and engagements in which he took part or was a witness of. His description of the privations which he and the soldiers under his command, and the army to which he was attached, demonstrated, if the fact needed such, that a

soldier's life in the time of war is anything but a desirable one. He had numerous hairbreadth escapes, on one occasion, while carrying despatches to the colonel of his regiment, being the target for a considerable time of a number of Federal marksmen. In the course of his lecture he paid a tribute to the generalship of "Stonewall" Jackson and Lee. When he left the army the war had almost come to an end. He closed with the hope that none of his audience might ever pass through a similar experience, and the prayer that "the weapons of our warfare may be spiritual, and not carnal."

Edward N. MacIlwaine, Esq., read a Paper entitled

HALF-AN-HOUR IN QUEENSLAND AND THE BUSH.

Mr. MacIlwaine, who has had a lengthened and varied experience in Queensland, then proceeded with his lecture, the first portion of which was devoted to a sketch of the large colony of Queensland, and a reference to a few figures showing the wonderful progress the colony has made since its foundation only thirty years ago. Mention was made of the principal industries which have contributed to the prosperity of Queensland, these being pastoral, agricultural, mining, and fishing. The lecturer gave some idea of the Bohemian life in the bush, and of the dangers attached thereto, dwelling particularly on the danger of being "bushed" or lost in the bush, and narrated the experience of a party of which he was one, who went in search of a missing friend whom they ultimately discovered dead. Mr. MacIlwaine gave a description of the Blacks and their mode of living, showing that they are one of the lowest races of humanity. The Aboriginals' annual assembly was described—an occasion when the whole tribe gathers for a week's hunting, and finishes with a coroborie. This coroborie was fully described, and a portion of one was sung by the lecturer, who accompanied himself with the clashing of boomerangs. The lecturer also

dealt with the insects to be found in the colony, especially ants, which, according to his idea, are not so clever or possessed of such great sagacity as some imagined. After devoting a few minutes to the birds of Queensland, including the laughing jackass, an illustration of whose laughter was given by Mr. MacIlwaine, he described the buckjumping horses, and drew on the blackboard a representation of this dangerous class of animal.

On the motion of the Rev. JOHN KINGHAN, seconded by Mr. ROBERT YOUNG, sen., the thanks of the Society were conveyed to Messrs. Murray and MacIlwaine for their interesting and instructive papers.

The SECRETARY (Mr. R. M. Young) announced that the following donations had been presented to the Museum since the last meeting :—A collection of above thirty birds shot by the donor, including such rarities as the whinchat, lesser white-throat, white wagtail, woodlark, short-toed lark, spotted crake, queen sandpiper, also the great bat, the white stoat, and the polecat, presented by Mr. V. H. Coates, Dunmurry ; and an ancient pewter dish, found in a drain 10 feet deep at Massereene Castle, Antrim, presented by Mr. Robert Patterson.

The cordial thanks of the Society having been accorded to the donors, the proceedings terminated.

6th January, 1891.

J. H. Greenhill, Esq., Mus. Bac., in the Chair.

DISCUSSION ON THE PROPOSED CHANNEL TUNNEL.

The Honorary Secretary (Mr. Robert M. Young, B.A., C.E.) read the following letter of apology from Messrs. Barton :—"Engineers' Office, Caledon, December 16th, 1890. Irish Channel Tunnel. R. M. Young, Esq., Honorary Secretary Belfast Natural History and Philosophical Society, Belfast. Dear Sir,—Yours of 8th inst. The investigations necessary to determine whether or not a Channel Tunnel between Scotland and Ireland may be safely undertaken, what it would cost, how far it would prove financially successful, and which would be the most desirable route to select, are as yet only in their initial stages. We think, therefore, it would not be advantageous to discuss the subject publicly until these investigations are further advanced, and until we are in a position to state the facts upon which a sound opinion may be based. At the public meeting in Belfast a very influential committee was appointed to investigate the whole question, and take the necessary steps to forward the project. We think that the discussion you propose would lead to a prejudgment of the case on insufficient data. We must, therefore, while thanking you for your offer, decline taking part in it.—Yours truly, John G. Barton (for Mr. James Barton and self)."

Letters of apology were also received from Messrs. J. H. Brett, C.E., County Surveyor of Antrim ; P. C. Cowan, C.E., County Surveyor of Down ; John MacIlwaine, M.I.M.E. ; A. B. Wilson, and others.

The CHAIRMAN said :—We are all aware that this question of a tunnel between Ireland and Scotland has received a considerable amount of attention of late. As Mr. Barton said, there was a public meeting held, under the presidency of the Mayor, to discuss the matter, and a committee was formed. I do not know whether that committee has done anything or not, but I do not agree with Mr. Barton that a public discussion of the matter, especially in a society such as this, is undesirable. I think it is most important that the various schemes should be discussed before a society which is not interested in any of them in particular. And whether the proposed tunnel is practicable, or, if practicable, whether it is desirable, is, I think, a question which comes within the province of this Society to discuss; and I believe the views of the various speakers will this evening be listened to with interest. With regard to the causeway, I have no doubt that, if practicable, it would be far more popular than any other scheme. There are of course enormous difficulties in connection with it, but I hope there are some present who will take the matter up and discuss it from the causeway point of view.

Mr. MACASSEY said :—It almost goes without saying, that if we had a tunnel completed between Belfast and Scotland it would be an immense advantage not only to us but to the rest of Ireland. It would be a wonderful thing if we could make the tunnel. It would exceed in importance the Forth Bridge. In fact, it would show that the engineers were wonderful men, and possessed, as a Russian gentleman had said, miraculous powers. I am not here, however, as an engineer to advocate any particular scheme. I am not here, like my friend Mr. Barton, or my friend Mr. M'Cullough, with any scheme of my own to put before the public, and which I wish them to take up, and engage me as engineer to carry out. I am here in connection with a subject to which I have given some attention, but which I do not advocate as a competing engineer. Now, the subject which we have met this evening to discuss has been before the public for a good many years in a general sort of a way. When

I was a lad I paid some little attention to it, and on my first arrival in Belfast I came before the public with an old friend, and we suggested a tunnel between Tor Head and the Mull of Cantyre. Meanwhile, attention was directed to the proposed tunnel between Donaghadee and Portpatrick. The places have been examined by a staff under Sir Edward Watkin. The tunnel would come in at the narrowest part of the channel, and would be connected with Belfast by rail, and, again, on the other side of the channel it would be similarly connected with Stranraer. The length of the tunnel would be about twenty-two miles, but the depth of the water towards the Scottish side is excessive. There is a sort of hollow or trough which lies along the Scottish side about three-quarters of the way across, which runs pretty well north and south, the depth of which is about 100 feet; and to get safely under a depth like that would require the tunnel to be at a very low level, and would entail very steep and lengthened approaches on either side. Now, I find that the twenty-two miles of sea channel would require about eighteen miles of approaches on each side, making altogether about forty miles, and the cost would come to about nineteen millions sterling. These are the two points against it: first, that it would cost too large an amount, and secondly, that it would be very difficult to work. There is, however, one fact strongly in favour of the Donaghadee and Portpatrick tunnel, and that is that the rocks on either side are peculiarly favourable for tunneling, and if we assume that those rocks are continuous through the bed of the channel it would be a mere matter of money and time to make the tunnel. But, then, we have the great depth to which we have to go, and the great expense of the undertaking, staring us in the face. I suppose, therefore, that Sir Edward Watkin has abandoned that route, because he has since directed his attention to a more northerly one—the route between Cushendall and the Mull of Cantyre, which I call No. 2. The length of the sea tunnel there would be about fourteen and a half miles, and with approaches the total length would be about twenty-four miles. In this route

the necessity for extreme sinking would be averted, and the estimated cost would be about six and a half millions. Though, as a matter of length and estimate, this is a very feasible route; it has this drawback, that it is so very far away. We want to get straight across to Scotland; but to get to Glasgow by this route we must construct about 100 miles of new line, while on the Irish side we should have to construct a line of about twenty-four miles from Cushendall to Larne, and also a line to Ballymoney for the purpose of communication with Derry; and in my estimate of six and a half millions I have not included the cost of these railways. The next route to which I will call attention is the No. 3 route, which is from Whitehead to a little north of Portpatrick. This route was brought before the public by Mr. M'Cullough, an engineer of considerable experience in Belfast, and has been commented upon pretty favourably in English and Scotch journals. Mr. M'Cullough has this advantage, that while he avoids the trough which I have already spoken of, he gets at the same time a comparatively short line. For the sea length there would be about twenty-seven miles. The depth of the water is some 650 feet. His estimate is seven millions. It practically gives us as good a railway connection on the Scotch side as the Donaghadee route, and practically also as good a connection with Belfast. The next scheme which has been brought before the public is that suggested by Messrs. Barton. It came before the public a considerable time after Mr. M'Cullough's. Mr. Barton, as we are all aware, attended in the Town Hall and explained his scheme, but he admitted that it was so far only a preliminary investigation. No actual soundings have been taken further than the Admiralty soundings, to determine the nature of the route, and no borings have been taken to test the rocks. Mr. Barton offered no opinion as to the geological character of the route, but he brought in Professor Hull to explain his views, and he told us that the data at his disposal were sufficient to enable him to form an idea of the rocks. But he did not give us his data, and that was unfortunate; for when we come before the public with schemes of that

kind it is not the usual course to ask the public for money and not tell them the reasons for so doing. My own private opinion is in favour of the route between Cushendall and the Mull of Cantyre. This route is open to the serious objection of these long connecting lines; but I cannot shut out from my own mind the fact that sea tunneling is a most difficult and onerous undertaking, and allowing in every way for probabilities, it appears to me that the probabilities are largely in favour of the northern route. But then, if we had a tunnel there it might be said by commercial men that they would prefer sending their goods direct by steamer. That, however, is not an engineering matter, and it is from an engineering standpoint that I have to deal with the question. It may be asked what experience we have in matters of this kind; in other words, what are the data on which we base our calculations, and ask the public to agree with us. In reply to this I cannot do better than state what has been done in the way of tunneling. As regards land tunneling of a difficult character, we have Mont Cenis, the St. Gothard, the Arlberg, and others. Mr. Barton, in his preliminary estimate, took the Arlberg as a basis, and took the cost of the route at £200,000 per mile, and then added for expenses of pumping and ventilating, which brought up the figures roughly to £300,000 per mile. Then we come to the Severn tunnel, nearer home. The cost in that case was, roughly, £500,000 per mile. Within the past few months has been finished the St. Clair tunnel, four miles long, and in that case the cost was only about £100,000 per mile. The construction was accompanied with very little difficulty and, I believe, no accidents. The mode of construction was very different from that employed in the case of the Severn Tunnel. Where there is water coming in it is a very difficult matter to line a tunnel, but the American engineers lined this tunnel entirely with iron plates, and by this means a great deal of difficulty was got rid of, and the tunnel was completed at a very low cost. I mention this last case to show that by adopting cast-iron lining plates we may get rid of a great deal of difficulty. If we adopt

this lining here we shall more readily secure the success of this project as an engineering scheme, and at the same time keep the estimate within reasonable limits. Putting the whole matter very shortly, however, I do not think that any tunnel between Scotland and Ireland would be a financial success. In fact, I do not know where we could get any body of sensible men to put their money into such a project, or where we could get any men outside a lunatic asylum to invest in it. The question is whether the Government in such a case would be a little grandmotherly—somewhat after the same manner as they are now constructing light railways in various parts of Ireland. This is a very important matter. I can conceive of circumstances which would render it desirable that such a thing should be done. To earn a dividend of 6 per cent. would require about £200 or £300 per mile per week of traffic. The Lancashire and Yorkshire Railway earns altogether £160 per mile per week, and to assume that we should have a traffic for this line double that of the Lancashire and Yorkshire is an assumption that I cannot venture to make. This may give a rough idea as to the improbability of the scheme ever being a feasible one. If the Government could see their way to undertake the scheme, however, I believe it would prove a benefit, though it would not pay a dividend. It would, I believe, make the relations between England, Ireland, and Scotland more thorough and cordial than at present, and for that reason I am sure all present will join with me in hoping it may come to pass.

Mr. F. W. M'Cullough, A.M.I.C.E., F.S.L., gave a brief description of all the tunnel schemes which had been put forward, viz:—

Scheme	No. 1.	From	Donaghadee to Portpatrick.
„	No. 2.	„	Cushendun to Cantyre.
„	No. 3.	„	Whitehead to Portpatrick.
„	No. 4.	„	Islandmagee to Weirston.

The No. 3 scheme (from Whitehead to Portpatrick) was his (Mr. M'Cullough's) scheme, and was the third tunnel scheme for crossing the Irish Channel, and the first one introduced

before the public for connecting the shores of Co. Antrim and Wigtonshire. This scheme would begin by a junction with the existing Belfast and Northern Counties Railway near Whitehead Station, some 14 miles from Belfast, and then running in a northerly direction for some 1¾ miles, would dip under the sea at Blackhead on the Northern shore of Belfast Lough, and passing under the Channel in a direct line of tunnel would enter the Scotch coast at a place called Millbawn, some 3 miles north of the town of Portpatrick, and continuing inland by land tunnels and open railways would terminate by a junction with the existing railway from Portpatrick to Stranraer at a point about 2½ miles from the latter town. The length of sea tunnel by this route would be 23½ miles, maximum depth of water 648 feet, and with a short ruling gradient on the Scotch side of 1 in 58 there would be an additional length of 3½ miles in the approach land tunnels, making a total length of tunneling under land and sea of 27 miles :—there would also be some 4 miles of new connecting railways. The total distance by this route between Belfast and Stranraer would be 47½ miles, or 7 miles shorter than by either the No. 1 tunnel between Donaghadee and Portpatrick or No. 4 tunnel (Messrs. Barton's) between Islandmagee and Weirston ; the gradients by this scheme would be better than the gradients by the other routes, having many horizontal stretches up to 2 miles in length.

Provision has been made in the estimate for constructing this tunnel for a double line of rails laid to the English gauge, and with an additional line of rail laid from Whitehead to Belfast to suit the change of gauge, so that a through system with English carriages and engines can be run into the Belfast terminus from any part of England or Scotland.

The method of construction in this tunnel would be the " Base Heading " or English system, which gets its name from the first or advanced tunnel heading being driven on the same level as the permanent rails would afterwards be laid. There would be four other distinct headings or enlargements before the

full size of tunnel would be formed, and in this way a regular system of construction at different stages at the same time could be constantly gone on with, and the progress made would be much more rapid than if carried out on the "Roof Heading" system. The tunnel heading, when completed to full size, would be substantially lined with masonry side walls and brick arching, except where a sound rock formation is met with. Proper ventilating and pumping culverts would be provided, as well as a vertical bratticing of brickwork throughout the entire length of the tunnel, to assist the ventilation and regulation of the air currents. The tunnel during construction and after completion would be kept clear of water by powerful pumping machinery erected near the main shafts to be sunk near the Scotch and Irish sides and to be connected with suitable mains laid through the tunnel. Permanent flooding would be prevented by means of specially constructed shields fixed at short intervals, and these would be so designed as to be at all times a place of safety for the workmen. The ventilation would be maintained by powerful fans supplying fresh air into specially laid mains in the tunnel, having branch air valves at short intervals, from any one of which the fresh air could be drawn into the tunnel when found necessary. The question of ventilation of the Irish Channel Tunnel would not be so difficult to master as in the Alpine Tunnels, as the natural temperature in the centre of the latter has been found to be about 118° Far. whereas the natural temperature in the Whitehead and Portpatrick tunnel would not be more than 68° or 70° Far. To have proper ventilation in tunnels exceeding 10 miles in length, especially when the traffic would come up to the average rate, the ordinary steam locomotive must be abandoned, and electric or compressed air engines used.

The cost of the Whitehead and Portpatrick scheme has been as carefully considered as the present preliminary state of matters will permit. After making ample allowance for everything, the cost of the earthwork and masonry work would be £206,844 per mile of tunnel, and allowing for cost of shafts,

new connecting railways, pumping, ventilation, and contingencies, the total cost of the No. 3 scheme would work out at £6,940,000, say £7,000,000, or £257,778 per mile complete. The time for completion would be about 8½ years, or a little over three miles per annum. Mr. M'Cullough considered the advantages of his scheme as compared with the others mentioned to be as follows :—The tunneling would be much shorter than either No. 1 or No. 4 scheme, and the cost and time of construction therefore much less. It would be cheaper to maintain and work than either of these. It would also provide a more direct and shorter route from Belfast to both Glasgow and Carlisle than any of the other schemes.

The following tabular statement shows the most important particulars of the four proposed lines of tunnel—

SCHEMES.	Length of Sea Tunnel.	Length of Land Tunnels.	Length of Connecting Railways.	Maximum Depth of Water.	Approximate Cost. Estimated proportionately at similar rate for each Scheme.	Estim'ted Time for Construction.
	Miles.	Miles.	Miles.	Feet.		Years.
Donaghadee to Portpatrick	22	16	3¼	over 900	£11,400,000	10¼
Cushendun to Cantyre	14½	9½	nearly 150	460	6,668,000	7
Whitehead to Portpatrick	23½	3½	4	648	7,000,000	8½
Islandmagee to Weirston	26½	6½	7 to 10	504	9,244,000	11

Distance Table *via* Different Tunnel Routes.

SCHEMES.	Belfast to Glasgow.	Belfast to Carlisle for England.
	Miles.	Miles.
Donaghadee to Portpatrick - - -	144	154
Cushendun to Cantyre - - - -	205	300
Whitehead to Portpatrick - - -	137	147
Islandmagee to Weirston - - -	144	154

Mr. MAXTON said :—One of the objections I have to entering minutely into the consideration of this subject is that I am the proposer of a rival scheme to those mentioned this evening—viz., the submerged bridge. I am greatly surprised at the little information the previous speakers have given as to the details of the engineering question ; speaking purely and simply as an engineer, not as a commercial man. Before saying anything with regard to the submerged bridge I should like to mention a few matters which it will be well to consider before contemplating the construction of any such tunnels as those under consideration. The first subaqueous tunnel of any consequence was that under the Thames, the construction of which was attended with disaster. It was closed for fourteen years, and cost two millions per mile. This is not an encouraging outlook for the proposed tunnel. The Severn Tunnel is the next case I will refer to. It took thirteen years to complete the four and a third miles of this tunnel, two of which are under water. The undertaking was abandoned for eighteen months, but was completed by the late Mr. Thomas Walker, one of the most remarkable contractors the world has ever seen. The tunnel cost between £400,000 and £500,000 per mile. At the present time the working expenses are enormous, and I am informed that the pumping engines alone consume about a thousand tons of coal per month. The water pressure is about sixty-four pounds to the square inch. I can speak personally of the Mersey Tunnel, which has been constructed on the most modern principles, by the most modern machinery, and cost £500,000 per mile. In my estimation it would cost a somewhat similar sum per mile to construct the proposed tunnel. The passenger traffic through the Mersey Tunnel is enormous—130 trains a day each way—yet the company has not paid a dividend up to the present. The pumping, ventilation, and lighting absorb over twenty per cent. of the gross income. One and a quarter miles per annum was the quickest advance made in the construction of this particular tunnel, and at this rate it would take fifteen years to drive the shortest proposed channel tunnel,

namely, that from Cushendall to Cantyre. Mr. Macassey spoke of the St. Clair Tunnel in America, but the circumstances in respect to it are entirely different. It was for the most part driven through soft material, and it will only accommodate a single line of rails. I think that Mr. Macassey must have taken his statements from some of the American papers. There were four years of preliminary consideration, and the scheme for a time, after a second attempt, was abandoned. Then it took years to complete, and under all the circumstances the American papers described it as the quickest driven tunnel in the world. I do not know that we can come to such a conclusion from a review of facts. The Americans take to themselves the credit of the St. Clair form of construction—this cast-iron lining—but if I remember correctly the London Subway was constructed on the same principle. The cost of the St. Clair Tunnel was stated to be £300,000 per mile. Having mentioned some other American tunnels which are proposed, Mr. Maxton proceeded :—Before it was decided to commence the work in connection with the Mersey Tunnel, a trial heading was run across the river. Supposing the proposed tunnel discharged 3,000 gallons of water per hour per mile, as does the Mersey Tunnel, it would require engines of 22,000-horse power to pump it out—engines twice the size of those of the Teutonic—and from this we can imagine what the cost would be. The expenditure on coal would be £600 per day, and the engines would cost about one million. I should not like to touch on the question of ventilation. If I did, I should have to go to Sir Robert Ball for those extraordinary figures he gave you in his lectures on astronomy. It would require engines of 3,000-horse power to ventilate the tunnel on the brattice system, but if the ordinary system were used the horse power would reach to millions.

I should like to say only a few words upon the method I myself propose to bridge the channel. The scheme is what is called a mechanical one. There is no digging, or delving, or mining, or quarrying about it. One great argument in favour

of this proposal is, I hold, the fact that the feasibility of the scheme could be tested by a section of the bridge being submerged in any portion of the channel. If it fails, £500,000 is lost, less scrap; but no such experiment can be made with the proposed tunnel, and any failure there means the loss of the money, and probably hundreds of lives as well. The next thing in favour of the scheme is the rapidity of its construction. Several naval architects have told me that they would be able to construct the bridge in five years. Contrast that with the ten or twenty years that would be required for the making of any of the undersea tunnels, which Mr. Macassey admits are very uncertain and risky undertakings. Now, structurally we are as certain of the result with regard to the submerged bridge as the engineers were of the Forth Bridge. The cost of working one of these tunnels would be greater, the cost of ventilation greater, and the pumping something extraordinary—something beyond the powers of conception, or supposition. Mr. Macassey said that the tunnel might be constructed in the same way as the St. Clair one, but such a thing would be impossible or practically prohibitive. You would require to drive two tunnels, but the pressure would be too great to permit of any such mode of construction. The tunnel-lining would have to be from ten to twelve inches thick, and we can all understand what a heavy cost the use of such material would entail. The pressure of the water would be from three to four hundred pounds to the square inch. In conclusion, as an engineer I am practically opposed to the construction of tunnels anywhere and in any way. I strongly object to them, and engineers, from the experience they have derived, wherever they can put up a bridge do so in preference to tunneling, and we have the Forth and Tay Bridges as instances. It is only because of insurmountable obstacles or strong opposition to a bridge that induce engineers to drive a tunnel, as they know that such an undertaking will be attended with many difficulties and uncertainties.

Mr. J. C. BRETLAND (City Surveyor) said:—I have lately

had in hands here a baby scheme of tunneling, some half-mile or so in length, which, I am happy to say, has now been achieved. Tunneling in a town is a difficult operation, and no doubt tunneling in subaqueous strata would be still more difficult. I think as so many operations of subaqueous tunnelling have been accomplished it is too bad to throw cold water on the schemes which have been put before you. It strikes me, however, there is no good in hiding the fact that in dealing with this question we are met with most serious physical and financial difficulties. None of the schemes that have been propounded to-night could be approached as a commercial transaction, but only by the State. We must desire calm and quiet discussion as to which of the rival schemes is the best to adhere to. Before that nothing practical can be attempted. Next, there ought to be most careful surveys and borings, and a heading made to show what strata might be expected to be met with. I cannot help being struck by the fact that, independently of the capital expenditure, there is a vast annual charge to be involved in draining and ventilating a subaqueous tunnel of this kind. In the Severn tunnel there are four large fans, 2 of them 40 feet in diameter. Passing through the Mont Cenis tunnel some years ago I was delayed for about one hour, and thought I should have died from the fearful heat that was concentrated there. I am sure it would require enormous expenditure to overcome the difficulties of ventilation in a large scheme.

The Chairman, alluding to Mr. Maxton's scheme, remarked that a tube could be made at a very small cost for the purpose of transmitting letters and parcels. This would give a sufficient idea as to whether such a scheme as the submerged bridge was feasible or not.

Conway Scott, C.E., said :—Mr. Macassey appears to-night with two identities, the distinguished Barrister and the eminent Engineer, but the first seems to predominate :—there has been a large amount of special pleading and a most limited amount of engineering facts.

The line of tunnel chosen by Mr. Macassey appears to me to be the most unsuitable of all :—the idea of taking a trip through the Highlands of Scotland in order to reach London quickly seems absurd, only to be equalled by Mr. Barton's sharp curve in the depths of the ocean.

Mr. M'Cullough's line seems to be the best; it is straight, and gives a proper connection with the English and Scotch railway systems. But to my mind the difficulties of any such scheme are so great that no Company would be justified in undertaking the work.

The advocates of these schemes seem to think that the bottom of the channel is a bed of concrete, through which you have nothing to do but to bore. Unfortunately there is little known of these rocks, and this is not favourable, these rocks being of a slaty and pervious nature, with many faults and fissures.

In former ages vast masses of molten matter have forced themselves up through these rocks, pushing, twisting, and disturbing them, and forming faults and fissures through which great quantities of water would flow. When the tunnel comes to such places it will be submerged, the miners drowned like rats in a hole, and all the pumps in the world could not clear it by raising the water 1000 feet high, as must be done.

The Panama Canal, engineered by the greatest talent of the day, is a dismal failure and a national loss to France. Yet it is doubtful if its difficulties were greater than those of a channel tunnel.

Great public works do not always pay the cost of construction. The Central Pacific Railway had a large mileage grant from Government, which was stretched to the utmost, but the line would not have paid working expenses were it not for the enormous land grants along the Railway. It is the increased value of such lands that pays the company.

The advocates of these tunnels agree on one point, that a paternal Government should undertake the work—knowing well that such schemes would be too much for even the gulli-

bility of the British shareholder, who has thrown away his money madly in the world.

The reason why the Government should throw away their money, is that the tunnel would be a bond of political union between the countries, and would break down all existing prejudices between England and Ireland, but this is very doubtful indeed. At a time when thousands of Irish patriots are sighing to break the last link that binds green Erin to the hated Saxon, would it be wise to make a 10-million link that any dynamite martyr could destroy in as many minutes?

Professor FitzGerald said:—I greatly prefer Mr. Maxton's scheme to the others. The necessity, which they involve, of going in for complete borings right through, points to the great advantage of any scheme in which the preliminary expenses will be diminished, and in which the results of preliminary investigation will be more certain than those of a mere heading-boring run through.

Mr. Maxton's scheme has been objected to chiefly from the point of view of civil engineers, who have a constitutional fondness for bricks and mortar. Yet no colossal bridge was ever made till the mechanical engineer had been brought into play; and if things had always been done on the steady old brick and mortar plan, neither the Severn nor the Mersey tunnel would ever have been made. Objection has been made to the difficulty of hauling 400 feet lengths of Mr. Maxton's tube into position. As I understand Mr. Maxton, there is no inherent necessity for such great lengths. But the difficulties of getting a ship 400 feet long into its place, when heavy moorings have been previously laid down, are not so very great. The thing can be done, and has been done with much more difficult things to move. Sections of bridges, mounted on three or four barges, raised 40 or 50 feet above the barges, have been hauled into position in any circumstances short of a gale.

As to depreciation of the tube, there should be no difficulty in making a kind of dry dock that could be moved about along the tube, enabling any part of the outside to be got at from

time to time; the moving blocks could be taken up, one at a time, for examination, and relaid. There is no insuperable difficulty, or even serious difficulty, in getting at any part of the thing whenever it may be necessary.

As regards preliminary experiments, there would be no serious difficulty—the expense would be less than that of a heading-boring—in sending out half-a-mile of tube and sinking it in the place where the water is 900 feet deep. Moor it and leave it there for a year. I believe it would be found at the end of a year all right. One piece of it moored is the same as any other piece. You can get your tackle arranged as you find best, and all these things could be worked at before the final estimates for the tunnel were made. On these accounts, and the greater cheapness and immensely greater rapidity of construction, such a scheme is infinitely preferable to the uncertainties involved in tunnels bored through rocks. Even if you have bored a hole, one hole is a very uncertain criterion of what may happen within 50 feet of that hole.

Sir WILLIAM QUARTUS EWART, in reply to the Chairman, said that nothing had been done since the meeting in the Town Hall, at which Mr. Barton had put forward his scheme, and no further communication had been received from that gentleman upon the subject.

Mr. E. N. MACILWAINE (Mechanical Engineer) said:—I wish to say a few words against the underground tunnel. I have had experience in Queensland of sinking two deep wells, 1660 and 1300 feet, and both these wells gave an enormous quantity of water. The pressure at the surface in the case of the 1660 feet well was 64 lbs. per square inch. An Artesian spring might be struck in sinking one of these tunnels, and if so the best thing would be to fill up the tunnel and leave it.

Mr. JOHN BROWN said:—There is one special reason why, as I think, Mr. Maxton's scheme is to be preferred, viz.—because the calculations in it are based on known quantities, whereas the other schemes include a large number of unknown quantities. We know for instance the properties of the water in which

the bridge floats, the effect of its motion and other actions, and we can calculate from known strength of materials the proper proportions to suit these known conditions. But in the case of the subaqueous tunnels we can have no idea, for instance, of the amount of water to be pumped out. The nature of the rock is also practically an unknown quantity, and I think the geologist is perhaps too sanguine as to his power of estimating its nature. I should say the geologist's habitual methods conduce towards an attitude of mind not suitable for an undertaking of this kind. In the ordinary pursuit of his science he allows his scientific imagination to roam over remote ages of the past where no one can contradict him and no one can gainsay his conclusions. And when he goes to the top of the Gobbins or Black Head and gazes over the inscrutable expanse of ocean before him, his mind is tempted, I fear, to assume the same attitude as in contemplating these remote inscrutable ages.

I should doubt the feasibility of Mr. M'Cullough's proposal to keep water out of the workings by air pressure, because the pressure required, corresponding to the depth of water, would be say 300 lbs. per square inch, and no one could live, I think, in air at anything near that pressure.

In a recent publication the difficulty of mooring the bridge has been compared to the difficulty of mooring a ship. A ship is no doubt very difficult to moor under certain circumstances, but it does not form a parallel case. A ship is not designed principally for being moored, but for motion. It is moored by one end only, and is acted on not only by current but by wind and waves. The bridge, on the contrary, is designed for mooring, is not acted on by wind and waves, and is moored at many points.

Professor Everett said :—As regards the great heat experienced in the Mont Cenis tunnel, it is simply the natural heat of the ground at that depth. Nothing of the kind would be encountered in a channel tunnel, for the temperature of the ground 50 feet beneath the bed of the channel would be only about 1° higher than the temperature of the bottom water. But

the other difficulties are so great that we must wait for several generations, and obtain more experience in tunneling on a large scale, before a submarine tunnel connecting England and Ireland could be undertaken with any prospect of success. He thought Mr. Maxton's scheme more feasible than any of the others.

The CHAIRMAN said that he feared a scheme of the kind could not be carried out unless the Government could be induced to construct a tunnel, believing that such an undertaking would be of material benefit to the country.

3rd February, 1891

Professor FitzGerald in the Chair.

Alex. Tate, Esq., C.E., read

The Report of the Society's Delegate to the last Meeting of the British Association.

Mr. Tate gave some interesting information with regard to the corresponding sections of that Association. He enumerated a number of most important and interesting subjects upon which local societies could very materially aid that Association in the collection of statistics and other important information, concluding with the hope that that and other kindred societies would do what they could in the direction indicated.

Professor FitzGerald said they must all feel very much obliged to Mr. Tate for the very great care with which he had collected the information requisite in order that the local societies might give their best assistance in obtaining data with respect to the various matters as to which Mr. Tate had spoken, and possibly some gentleman present might have suggestions to make as to any local societies or associations which had got special information or details as to some of the points brought forward.

Mr. Gray said he was much obliged for the kind way in which he had been referred to by Mr. Tate. He wished to refer to one point particularly, namely, the destruction of our native plants. The common ferns we love to see along the local hedgerows have been wantonly destroyed or uprooted and sold by irresponsible dealers, and he applied to the Members of the Society to exercise their influence on the public generally, in order to discourage this destruction of native plants along our local hedgerows.

Dr. Howard Sinclair then read a Paper on

"SOME RECENT ADVANCES IN SCIENCE—MICRO-ORGANISMS AND THEIR RELATION TO DISEASE."

Dr. Sinclair said :—I had originally intended to take up the discussion of some of the principal medical discoveries of the century, but, finding the material at my command so great, and the time allotted to me so small, I have decided to confine myself to the subject which I have announced.

Dr. Sinclair then went on to describe the history of the discovery of micro-organisms, and the progress of science in the study of such organisms in relation to disease. Upon the subject of consumption he said:—The tubercle bacillus has been a great deal talked about of late. I need scarcely tell you that it is the bacillus without which consumption does not exist. This bacillus is now regarded "as the centre around which all the phenomena of consumption must revolve ; thus the causation of consumption is the life-history and habits of the tubercle bacillus, including the conditions most favourable or unfavourable to its growth in the body, its symptoms, the effect it produces upon the body, and its cure by the use of agents that will destroy it or render the soil of its selection infertile for its growth."* The discovery of this important fact was made some eight years ago by Robert Koch, at that time a practitioner in Breslau, in Silesia. It was by his long-continued experiments with staining processes that he at last hit upon a successful method of staining this tubercle bacillus, whilst the remaining bacteria and other tissues remained unaffected. His discovery later on of the bacillus of cholera (to make further investigations on which he went to India) has made his name known in every scientific circle in the globe ; and it is certainly an encouraging fact for biologists that the man who had discovered the means of

*Whittaker on Tuberculosis in Sajou's Annual of the Medical Sciences, Vol. 1, p. 1, 1889.

detecting the tubercle bacillus should now a few years later furnish us with means, in certain cases at all events, of accomplishing its destruction.

At the late National Congress at Berlin in August last Dr. Koch read a paper in which he gave some of his experience in the use of various germicides. He stated that he was then carrying out investigations which he was sanguine would enable him shortly to make known a remedy, which he believed exerted a curative effect on tissues infected by the bacillus tuberculosis. Some three months later he gave the account of the action of this remedy, which created a world-wide excitement unequalled in medical history. The composition of the remedy was, however, kept a close secret. Those best acquainted with Koch believed that his motives in doing so were perfectly disinterested, and that he only refrained from making its composition known until sufficient experiments had been made to prove the importance of the remedy. The steps by which the discovery was made have been already dwelt upon in Koch's own words in the papers. At first, in conducting his experiments, he used pure cultivations of the tubercle bacilli themselves, killed, finely pounded, and suspended, and he found that, though these injections had curative effects, yet they produced small suppurating centres. He sought, therefore, to find out how this matter-forming tendency could be removed from the remedy, and at last succeeded, by making a glycerine extract from pure cultivations of the bacilli, in producing the remedy which is now on its trial throughout the civilised world. The active principle of the remedy is in consequence practically a derivative of albuminous bodies, closely allied to the *tox-albumens*, though it is shown not to belong to them by its withstanding high temperatures. The amount of this active principle present Koch estimates at fractions of 1 per cent. How does Koch's remedy act? Koch's explanation, which he does not profess to be by any means the final one, is that the bacilli form a necrosis-producing substance. If to the already formed necrosis-producing substance a still further artificially prepared one is added, not

only would this be the case, but the more completely necrosed tissue would disintegrate, slough, and where possible take with it the enclosed bacilli, carrying them outwards. This explanation accounts consequently in a very natural manner for the much more rapid effect which is seen in the action of the remedy on external parts which have been attacked by tubercle. That the action of the fluid is precisely similar in internal organs has been conclusively shown by ocular demonstration. Have we then no practical lessons to derive from all these life histories of germs? First, sufficient evidence has now been accumulated to prove the value of bacteriological researches in revealing knowledge of importance to the national health, and showing the advisability of the establishment in the United Kingdom of hygienic institutes similar to those of France and Germany. Second, the importance is proved of systematic sanitary arrangements for the drainage and the proper cleanliness of our streets, which precautions are proved to have the effect of notably diminishing the number of disease-producing (pathogenic) microbes. Schnirer, of Vienna, a city whose streets are not noted for cleanliness, has shown that street dust there contains quantities of tubercle bacilli. He took a bunch of grapes from a stall where they had been lying exposed for sale, and found that on rinsing them the washings contained tubercle bacilli. Cornet's researches in Berlin with regard to micro-organisms in street dust has so far met with negative results. I am not able to give you any particulars of the street dust of Belfast, but I am sure that it would be capable of yielding a plentiful crop of tubercle bacilli. Lastly, the facts have been established that no germ will grow unless it has a suitable soil; and that the most suitable soil for many of the germs is where the vitality of their host is weakened. Consequently hygiene, which is a thing which neither State nor sanitary authorities can procure, must be a matter for every individual personally to see to.

Dr. Henry O'Neill said:—I have listened with much pleasure to the paper just read by my friend Dr. Sinclair on the important subject of micro-organisms.

As regards the tubercular micro-organism, called tubercle bacillus, which was first clearly demonstrated by Dr. Koch, and by him shown to be the cause of tubercle, we surgeons and physicians are more immediately concerned.

During the past year Dr. Koch has prepared a fluid called Tuberculin, which he believes will destroy the materials in the animal body on which the tubercle bacilli grow and increase.

This fluid is very strong, and it has to be largely diluted before using. Of the diluted fluid about two milligrammes are injected under the skin by a hypodermic syringe. In about seven hours the patient becomes feverish, and complains of severe headache, pain in the back, and shivering. The part of the skin affected with tubercle (lupus) becomes red, swollen, and painful. Gradually these severe symptoms subside, and in about twenty-four or thirty-six hours the patient feels free from any inconvenience. The hypodermic injection is repeated every third day for about five or six weeks, according to the severity of the case. If the disease is mild, a shorter course of treatment may be sufficient. The patient must keep in bed during the first two days. After about six injections the symptoms caused by the tuberculin become less severe, so that the patient has only to remain in bed for about one day after each injection. At present I am using the remedy in a case of lupus of the skin of the face, and for so far the disease is becoming less, but the feverish symtoms have been rather severe.

The use of tuberculin is not free from danger, as I find that in Berlin alone, during about two months, 27 deaths have been reported of persons suffering from various forms of consumption who have been treated by tuberculin. It is, therefore, necessary to use this remedy with great care and caution.

Some physicians have reported cases as having been cured by the use of this remedy, but I do not believe any person is in a position, at least at present, to show clearly a case of cure. Tuberculin is on its trial, and should it become as useful in the cure of consumption as its originator, Dr. Koch, states it to be, the medical profession will hail with pleasure another

means of treating successfully this fearfully fatal disease. By ordinary methods of treatment, such as good food, fresh air, sunlight, warm clothing, and gentle exercise, mild forms of consumption have been much benefited, and some cases cured ; and in using tuberculin all the above mentioned conditions have to be fulfilled to ensure success.

It has been very interesting to me to hear Dr. Sinclair's paper, and to see the demonstration of the various forms of micro-organisms so ably given by him to-night.

Dr. King Kerr said :—I think a mistake has been made in bringing this subject before the public in the way it has been brought—this Dr. Koch himself admits—the result being that, whereas in the first instance there was a rush on the part of the public to have recourse to the treatment, there is now a reaction, a tendency to hold back, on the part of patients whose cases seem most suitable ; and the utmost difficulty has been experienced in persuading them to submit to the treatment, because they have read of so many deaths from it. Many absolutely refuse to be injected, though strongly urged by their medical attendants. I think this is due to the fact that in the first rush many patients flocked to Berlin and other places in the most advanced stages of consumption, and insisted upon having the remedy used ; for when a person feels he is dying of disease, and presses you to give him at least the chance of life, it is very hard to resist the entreaty ; and the result has been, to a certain extent, to bring the remedy into disrepute. The only cases in which any very marked benefit has been seen are external cases such as lupus, and undoubtedly in these the effect is most marked. I have seen one case especially, that of a woman whose features were quite repulsive from this disease :—after a few weeks' treatment the repulsive aspect had disappeared, and there was every reason to hope that in a short time she would be as well as it was possible for a person to be who had lost a very large portion of tissue. Other cases are still subjects of doubt. I have seen some cases of joint disease

apparently cured—one was the case of a child who before injection experienced very great pain on the least movement of the limb, and who after about six weeks' treatment was able to run about and walk. On the other hand, whilst it has been stated that there were two cases of phthisis, or consumption of the lungs, cured, I think that is a matter which must still be open to doubt. I have myself seen one case in which it had undoubtedly done harm ; and therefore, as Dr. O'Neill has said, we must use very great discrimination in the application of the remedy and in choosing the cases ; but, undoubtedly, whatever the outcome of this form of treatment, the discovery of Dr. Koch has marked a very important epoch in medical science.

Mr. Brown said he had seen in one of the scientific papers that Professor Virchow is of opinion that the injection communicates tubercular disease to patients in some cases, or adds to the disease when already present. He should like to ask the friends on Dr. Koch's side if they could say anything on that question.

Professor Everett said :—We should be perfectly certain that it is a real remedy before we go into ecstacies over it. No doubt it will be thoroughly tried, and I hope the caution which Dr. O'Neill has recommended by example as well as by precept will be carried out generally, and that there will be no rash experiments made, at the sacrifice of human life. I hope there may be important results in the way of curing and preventing disease. Prof. Everett concluded by moving a vote of thanks to Dr. Sinclair for bringing the matter before them in the way he had done.

Dr. J. MacCormac said:—I think the discussion of this subject is quite in harmony with the objects of our Society. The treatment of disease, Dr. Koch's remedy included, perhaps might be more suitably discussed before a purely medical society ; nevertheless what Dr. Sinclair has stated cannot fail to be

interesting to every member of the Society. At the present time some people seem to think that these organisms and consumption can be wholly and for ever expelled from the human race by Dr. Koch's syringe and lymph ; but Dr. Koch has never himself put forward such a claim. He is undoubtedly entitled to much honour for his discovery, and, I will also say, for his warnings concerning its use. It is a remarkable remedy, and also in many cases a remarkable poison. The time is too short to speak dogmatically for or against the remedy ; but many patients undergoing treatment have died, and the time is too short to say definitely that any one case has been permanently cured. In my opinion Dr. Koch's remedy might come into use with the other earlier means at our disposal, and may have the effect of relieving suffering and prolonging life.

Professor FitzGerald said:—I have a letter from Dr. Lindsay expressing the same view as Dr. O'Neill's regarding the danger of hasty application of the remedy.

Judging from analogy, we have a right to expect that it may be possible to attack consumption by some method like inoculation.

With regard to the bacilli supposed to be imported from planetary space, if the rule of diminution of strength of virus by cold is applicable to them they should be perfectly harmless, on account of the extremely low temperatures to which they have been exposed.

The "vital" theory seems to me merely to restate in very learned language the common opinion that a person who has once had an infectious disease is less liable to the same afterwards. It says that the microbes are like dogs or fighting cocks, which when once beaten will not fight with the victor again ; but that does not sound like an intelligible theory.

The only intelligible theory I have heard formulated is the "poison" theory, which says that the products of these bacilli in the system poison the system and poison the bacilli themselves.

There is another point which Dr. Sinclair mentioned—the existence of dust in Belfast. I had been under the impression that there was nothing but mud. I remember seeing a short time ago an account of experiments made on a vessel at sea to ascertain the quantity of dust and the number of microbes in the air at sea. It was a well ventilated ship, one of the large Atlantic liners, and the amount of dust and the corresponding number of microbes seemed to be much the same as they were anywhere else. On deck there were a few less, but only in the very bows of the ship was there any marked scarcity of microbes; so that I am afraid it is not probable that there is any possibility of getting rid of a large number of diseases by doing something to the dust of a town (or the mud, as the case may be), seeing that, on the top of a mountain, or in a ship at sea with a good breeze blowing, we have practically as much dirt and dust in the air as we have in an ordinary place in town. As to Dr. Kerr's remarks, I think the reason for ventilating this subject in a Society like this is that people hate to be treated in the dark. They want to know as much as they possibly can, and they want to be assured, as Dr. O'Neill has made perfectly clear, that the doctors here will not recommend the remedy unless they have some fairly satisfactory reason for expecting that it will operate favourably.

Dr. H. Sinclair, in reply, said :—I have to thank you all for the very kind way in which you received my very imperfect paper. It was not my intention to do more than take up the bacteriological aspect of the question, because I think with Dr. Kerr that a natural history society is not exactly the place for discussing therapeutics and the treatment of disease. With regard to what Prof. FitzGerald mentioned—the occurrence of microbes at sea in as large a number as they do in towns—I think it is not so much the number of microbes as the kind of microbes present which is of importance, and what I referred to more particularly are those known as pathogenic or disease-producing. Every portion of the air contains large numbers of micro-organisms, but

they are not all of a disease-producing character ; every infectious disease has its own microbe. These malignant microbes are not present—not so largely present at all events—except in centres where they have been more or less encouraged. That has been shown by experiments in Berlin and other large cities. With regard to what Mr. Brown said, Professor Virchow's paper on the subject is a very strong argument against the indiscriminate use of Koch's remedy. It came as a very great shock to many people who thought, as the *British Medical Journal* said a week ago, that all they had to do was to have a bottle of lymph and a syringe to cure everything. Prof. Virchow shows the necessity for the most extreme caution in using the remedy. So far as I know about the use of the remedy in Belfast, I do not think there have been any deaths among the patients treated ; but I just happen to know, from my own experience, of eight people who came to me wanting to be treated, which I very fortunately declined to do. These eight people are now dead. Had I treated them, their deaths would, no doubt, have been attributed to the remedy.

The lecture was illustrated by a series of micro-photographs of bacilli by Mr. John Brown.

March 3rd, 1891.

J. H. Greenhill, Esq., President of the Society, in the Chair.

William Workman, Esq., read a Paper on

VENTILATION WITH HEATING.

The extreme of bad ventilation may be found in some of our cross-channel steamers, where ladies are occasionally carried out in a fainting fit. The sea gets the blame of much of the sickness which should be attributed to foul air. Ventilation requires careful consideration only in cold countries where artificial warmth is required. In summer, and in hot climates, open windows and doors are the rule, and drafts are courted rather than shunned. But a frosty night reverses all this.

For places of public meeting the open fireplace has long ago been given up, and with it, in general, the small modicum of ventilation secured by its chimney. Hot water pipes, as usually applied, do nothing for ventilation. Sometimes they are placed to warm air which may happen to come in at a ventilator, but one rarely or never sees an enclosed column of heated air used either to force in pure air, or extract the foul. The power of a column of heated air is so commonly in use for forcing air through furnaces, as for example in the funnel of a steamer, or in a mill chimney, that it seems to have been forgotten in ventilation. A simple opening in the ceiling of a hall or church, where the temperature is at most 70 to 80 degrees, diminishing to 60 degrees as you descend to the level of the heads of the audience, can have little power to extract air, compared with a much smaller opening, with a tube descending some feet to a

group of gas jets, and filled with air at a temperature of two to four hundred degrees. But the difficulty in ventilation does not arise from the want of means of drawing away foul air, or of driving in fresh air. It comes from quite a different cause, which, when traced to its source, is hidden in the three letters £ s. d.

Our usual means of producing heat are too slow and wasteful in their operation of warming a sufficient quantity of air, to make ventilation, as usually carried out, anything more than a mere excuse. With such sources of heat as these no audience would endure the amount of ventilation required for health. Take any of our public buildings in which people assemble, ventilated as they are at this time of the year, allowing it to be no more than three-fourths full. Provide this assembly with all the necessaries of life, how many would be painfully ill in 24 hours? How many, inside a week, would have to be carried out dead? Release the survivors, if any, at the end of a fortnight, how many of these would be fatally striken with consumption, fever, and other diseases? The experiment dare not be tried on human beings, but the results may be guessed from what has been tried on animals. How often do we find consumptives trace the commencement of their illness to a cold, caught at a dance, a concert, or a church, according to their respective tastes, whose illness would have been only a cold, and nothing more, if it had not been for the poisoned air inhaled?

The ordinary method of ventilation is to have a few openings in the ceiling to carry away the hot foul air. Some of these ventilators may do this in an indolent way, like workers paid by time when their foreman's back is turned, while others are mischeviously taking delight in pouring a stream of cold air on the heads of venerable persons, whom age has deprived of their proper protection. Another method is to provide a few openings in the lower part of the building to admit fresh air. The third and more perfect method is to combine these two, and have openings both of admission and of exit. The first methods being plainly defective, as air cannot be drawn from

an enclosed space without an opening for its entrance, nor sent into an enclosed space without an opening for its escape, we need not give them any further consideration. The third plan is wasteful and unscientific. It is wasteful of heat. The warmest being found at the ceiling will escape there, without benefit to the audience below, no matter how that warm air is produced, whether by hot water pipes, or heated air taken fresh from the outside, or merely the foul air of the building passed over the surface of a stove. The first act of such heated air is, to make straight for the ceiling with a velocity in proportion to its height of temperature. On its way upwards it mixes a little with the cold air, warming it, and carrying it with it. The only part of this warmed air which adds anything to the comfort of the assembly, is the surplus which has not been hot enough and active enough to escape by the openings in the ceiling.

Suppose a building heated by a current of warm fresh air introduced at the level of the floor, with openings in the ceiling for the supposed exit of foul air. If these openings are capable of discharging one half of the amount of hot air introduced, then as the hot air rises immediately to the ceiling, and as the hottest will rise fastest, and be the purest because it has lost the least part of its heat by mixing with the contained air of the building, the hottest and purest half of the hot fresh air introduced will be immediately wasted. It can contribute nothing to the ventilation, and very little to the heat of the room, though it may heat the ceiling before it escapes. The other half of the air will escape by seams in the windows, doors, and floor, and that portion of it only which comes down to the level of the assembly will be available for heating and respiration. It seems doubtful if this plan of ventilation will give better results than hot water pipes, or a source of heat that merely warms the aerial contents of the building, mixing them all up into a homogeneous mass of foul air, and allowing a portion to escape at the ceiling. By this method especially, if fresh warmed air is sent in, very little of the respired and polluted air will get an opportunity of escaping by the outlets in the ceiling, the respired air

not having a temperature sufficiently high to enable it to compete successfully in the race to the ceiling with the warmed fresh air. Some of the respired air will be caught up with the stream of products of combustion of the gas jets, and may escape, but for so far there does not seem to be any place where the ventilation is so abundant that more than a fraction of the gas products are got rid of. This system of ventilation resembles in its wastefulness the plan of grazing cows in a field, where they trample and befoul more than they consume. It is for this reason of wastefulness that writers on ventilation demand such a large amount as 2,000 cubic feet of air per hour to make a healthy atmosphere for a man ;—this air is simply mixed with all the air in the chamber, and dilutes its poison down to a point that is not perceptibly offensive ;—while for an hospital with sick persons, 6,000 cubic feet per hour is required for each patient.

The purity of the air of a room is determined by the proportion of carbonic acid present. The air becomes oppressive when the acid is above 15 per ten thousand. But this gas is not the worst foe to dread. The vapours given off by the lungs and from the surface of the body are more dangerous. These vapours do not diffuse with the rapidity of the carbonic acid. They require a current of air to disperse them. Carbonic acid, although it diffuses, yet, as Dr. Letts on a former occasion showed to us, will remain in a vessel for a time with a definite surface like a fluid. There is reason to believe that the respired air and the emanations from the body may tend, if undisturbed, to form a stratum in which an assembly in a crowded room is bathed. The respired air given off is so rapidly mixed with the surrounding cold air, and is so loaded with vapour and carbonic acid, both these combined being heavier than pure air, that it seems to have little tendency to ascend, as can easily be tested on a calm day, when it is possible to have the pleasure of sharing in the pipe of the gentleman walking some twenty yards in front, or better still, in his last glass of whiskey ! On a frosty day when from its warmth the tendency of the breath to rise should be greatest, it may be seen streaming from a horse's nostrils as

the animal walks along, and remaining very much in the place where it has been ejected. The question of ventilation, when artificial warmth is not required, is however outside our present consideration, as before stated. It is plain that it would greatly facilitate the matter if instead of 2,000 cubic feet per hour per head, we could get a comfortable wholesome atmosphere with 200 or 300 feet. This would reduce the cost of heating to one-sixth, or one-tenth, of that required for 2,000 feet, and would in the same proportion reduce the risk of sensible drafts. This is perhaps too much to expect, but it is a direction worth experimenting in. Besides, we have to remember that from the patience with which people suffer under the present state of affairs, they may be expected to be exuberantly happy with a state of affairs that will not more than a quarter choke them.

What led up to this idea was the ventilating and heating of a new National School in a district where, in a neighbouring school, the people seemed to be eminently indifferent both to heat and ventilation. This latter school was found in a raw stormy day with the fire extinguished because of a smoky chimney, and the door wide open to prevent the shivering children being absolutely poisoned on going out of the fresh air direct into this school. Even with the open door there was no exit for the air inside to make room for that which wanted to come in from without. The odour was simply sickening. The careless indifference of the people did not seem to promise much appreciation of an effort to give them good ventilation. Still, human nature has an innate desire for warmth on a cold day, and likes to have the miserable results of bad ventilation removed, even although it may not know the cause. Besides, to neglect juvenile humanity is taking upon oneself the unlawful privilege of visiting the sins of the fathers upon the children.

A new school-room was built. The method adopted for its ventilation was, when building, to have an equal number of ventilators placed in each of the four walls under the floor, to prevent a wind in any one direction affecting the supply of air to the school, by causing a down draft through the stove

outwards. Two flues were built side by side ;—they were badly placed for smoking in certain winds, but their position was not under the control of the ventilator. One flue carried away the smoke, the other carried away the foul air through an opening about a foot from the level of the floor. The stove used was the smallest size of Sirocco Stove made, modified by having the outer casing carried down to the level of the floor, a large hole being cut through the floor beneath the stove, admitting the fresh air to be heated. When heated, this air made straight for the ceiling, spread itself out in a layer, cooled slightly, and was continuously displaced downwards by fresh layers of heated air supplied by the continuous flow from the stove. In about two hours from the lighting of the stove, the heat became agreeable at the level of the inmates. This was plainly too slow, and arose from several causes—the ceiling was lofty, going up to the slates and sheeted with wood, the seams necessarily allowing a portion of the pure hot air to escape. The other cause seems to have been want of extra large ventilators through the walls under the floor. Doubtless these were looked upon as an excellent source of cold, while from the construction of the stove they were really the only source of warmth. As it was hopeless to attempt getting larger ventilators put in another method had to be adopted. Want of faith led to another impediment to the rapid heating of the room. Unenlightened human nature has an inveterate habit of closing all openings that might possibly admit cold air, even when their function is to let it escape. This brought about the careful closing with a sliding shutter of the flue opening near the floor, intended to carry off the foul air, and, being at the lowest level of the room, also to carry off the coldest air present. Very likely this flue is by this time carefully pasted over with paper and its existence forgotten. The remedy adopted was to add a casing to the height of the stove making it and the stove into a hot air flue, in all rising six feet from the level of the floor, first removing the ornamental grating from the top of the stove, thus getting rid of its friction on the current of hot air and more than

doubling the height of the column of heated air, and so more than doubling the power of its flow. The shutter was ordered to be taken off the exit flue. The result was all that was expected, the room was warm at the level of the inmates in one hour, instead of two as formerly, from the lighting of the stove.

Before these alterations were made, on going into the school room just before closing time, ninety children and two or three teachers having been in it for about four hours, with closed doors and windows, the room was comfortably warm, though it was cold enough to walk with a heavy overcoat outside, there was a decided odour of humanity, still it was not at all oppressive, although disappointing to the designer. After taking measurements of the rate of flow of the air into the room through the stove, and its rate up the exit flue, only then opened, the idea suggested itself to try with the hand if there was a perceptible increase of temperature at an elevation from the floor. To ascertain this the teacher's platform was mounted, then his chair, and lastly his desk. The result was as expected, but a result quite unexpected was the disappearance of the smell previously mentioned. Apparently the strata of pure warm air kept steadily descending with little to break their continuity excepting the rush of hot air through them from the stove as it ascended at the lineal rate of some 300 feet a minute. There has been no opportunity for making observations since the new arrangement has been in use. There is probably more than double the amount of air carried in. The top of the hot air flue being well above the heads of the inmates, there will be little or no tendency for the up rush of hot air from the stove to carry any of the respiratory products with it, making it more likely that the warm air will come down to the level of the heads of the occupants pure, and in unbroken strata, and when it gets into their lungs it should keep their heads clear enough to make a rational speaker easily understood. By the above process of reasoning and experiment we have apparently got the pure air down to the noses of the audience, nature comes in to assist us in getting rid of the respiratory products without the

disagreeable necessity of passing them through the mill a second time. Even Hibernian noses are not so much turned up that they can shoot their breath above their heads like a locomotive, but the stream goes steadily downwards to enrich the vegetation on the ground ;—so, if the theory be correct, in a properly ventilated and heated building, the breath being expelled downwards into the lower and colder descending strata, the slowly descending warmer strata should never give it an opportunity of again rising like a ghost to claim a home in, and trouble its former abode.

The heating of this school has a moral aspect worthy of note. In the mechanical world we have a gas engine called a "Domestic Motor." The little Sirocco Stove in this school might very well be called a "Social Motor" of unknown power. Scientific men have not yet attempted to form any accurate measure of this kind of power. It has not a market value, unless you can charge for tickets of admission. It draws a crowded house a full hour before the engagements of the evening service begin, seats in its neighbourhood are at a premium, while those at a distance are not at all despised. It is a warm-hearted and generous little stove, dispensing its benefits widely.

We will now bring our thoughts nearer home to the Belfast Soldiers' Home, where this theory of heating and ventilation is in part carried out. As before, the fresh air is drawn through the ventilators under the floor, which are larger and more numerous than usual. It passes into the stove through an ample hole. The outer casing of the stove being in contact with the floor, no second-hand air from the inside of the house can pass through. The stove can only deliver heat by bringing in fresh air. The top of the stove is continued upwards by a casing divided inside into four tubes, each having an area of a square foot, and each being provided with a valve to close it, or vary the quantity of hot air passed to each of the four rooms in which they terminate. Two of these rooms are on the ground floor ; in these the hot pure air is delivered close under the ceiling. In the two upper rooms immediately above these, the hot air is delivered through gratings in the floor.

The idea of keeping the strata of warm pure air unbroken by the rush of this hot air through them from the floor to the ceiling, had not completely matured when this arrangement was designed. This may be an advantage, as it will give an opportunity of comparing the effectiveness of the two plans. The ceiling of the rooms being fourteen feet high, there will be the power of a column of hot air of some fourteen feet in height driving air into the upper rooms, and of thirteen feet in height in the lower rooms. This of itself would deliver a large quantity of pure air, but as well managed Soldiers' Homes are frequently crowded to overflowing, an additional power of ventilation has been provided. This is accomplished with a centrifugal fan driven by a gas engine. Tubes, controlled by valves, lead from the level of the floor of the public rooms to the fan. These tubes will carry away the cold foul air at a moderate rate without the fan being put in motion, so long as the stove is driving air into the rooms by its heat. To give a homely effect to the rooms there is an open Marlborough grate in each. The grates when lighted will assist the ventilation. Even when not lighted there seems always to be a fair draft up the flue, probably caused by wind blowing across the chimney.

The rooms are lighted with Siemens's Regenerative Lamps, hung under ventilating tubes, without any special alteration of their pattern to suit ventilation. The distance from the funnel of the lamp to the opening of the ventilator is about a foot. The hot current from the lamp for such a short distance cannot cause much disturbance of the horizontal strata of the warmed air. This leaves the rooms with nothing more to deal with in the way of ventilation than the emanations from the assembly. Should the theory of ventilation by descending strata of warmed air not prove correct, there will still be sufficient change of air to prevent the atmosphere of the rooms becoming oppressive during the time of an evening gathering.

By measurement in the school before mentioned there was a discharge up the foul air flue of 165 cubic feet per minute, and the smoke flue was probably taking away an equal quantity. It

would have a tolerably high temperature to help it, but would be retarded by friction in passing through the fuel. It would be hard to estimate the amount of air escaping through the seams of the boarded ceiling, but for the purposes of ventilation that may be neglected, for what would escape there would be pure unrespired air, as explained before. From this we may fairly estimate that a comfortably pure atmosphere was maintained in the school for some four hours. It was comfortable, that is not oppressive, at the end of that time, with a change of air of only 215 feet per head per hour. We may take it for granted that nearly all the air entering the room passed through the stove and was heated there. The action of the stove would tend to produce a slight elevation of the pressure inside the building compared with that outside, consequently air would not tend to come into the building excepting through the stove. It was hardly possible to measure the quantity of air passing through the stove, the opening being about two feet long by one foot broad, and there was not an even draft over the whole area. There was no available means of contracting the orifice to cause an even flow. There would be more than 20,000 cubic feet of air passing through the stove per hour, but rather less than this was available for respiration.

The Siemens's Lamp in the lecture room of the Soldiers' Home consumes 40 feet of gas per hour. If the products of combustion of this were allowed to pass into the room, as is usually done, they would add to the carbonic acid present as much as 43 men would produce in the same time. The room will seat about 220 persons. Suppose it were shut up closely, it would only contain air enough to form a healthy atmosphere for six men for one hour. This seems to show that money would be better spent in supplying well-warmed pure air, than in large buildings with the hope of making them airy because of their size. If the upper third of some of our public buildings had been left unbuilt, it would have saved a sum of money sufficient to have endowed them for ever with warmth and ventilation in abundance, and probably have left sufficient to endow for the most luxurious lighting also.

The PRESIDENT said:—I wish to ask if there is any special merit in the "Sirocco" stove compared to any other dry stove in the market; and I would also like to ask, with regard to the heating of churches and other buildings where there are large windows, if the system of ventilation Mr. Workman has advised holds good. My reason for doing so is simply this, that in the church I attend there was a draft, apparently from the ceiling, but it altogether proceeded from the condensation of the large windows, and as soon as some hot water pipes were placed at the base the downward draft immediately ceased. Hence I should like to know whether it is possible to employ this system of hot air to overcome a defect such as I have named.

Mr. J. BROWN said:—There would appear to be two great systems of warming rooms, one by heating the air in the room, and leaving it to communicate its heat to objects in the room; the other by heating the walls, furniture, etc., by radiation from an open fire. The latter, which I take for various scientific reasons to be the better, is the method adopted by nature where the sun heats the ground by radiation; the ground in turn warming the air in contact with it. We do not, however, even with open fires, follow this method completely. We carefully arrange them so as to heat the ceiling instead of the floor. We put them down in the base of the wall and then raise a barricade in the shape of a fender in front, with the result that most of the radiant heat goes to the ceiling, where it is certainly not wanted. The sun is, of course, not down on the ground but up in the sky, and we should do well to imitate that arrangement. I should not put the fire place in the ceiling, but I would raise it considerably above the floor.

It is much to be wished that the directors of our public halls would take this matter of ventilation to heart, and endeavour to save people from the effects of foul air, which so often results in their being taken out in a fainting state. In his illustration showing that persons closed up in a large room for a week, even with food provided, would probably be found dead at the end of

the time, I fancy the Lecturer had the Ulster Hall in his mind, though he did not mention it.

Prof. FitzGerald said :—I did not hear the beginning of the paper, but the diagrams show pretty clearly what the system of heating the air is. I am very much of opinion that there is sound philosophy in the ordinary practice of putting a fire low down ; for, as the temperature at which the air of a room must be kept is remarkably different in cases where the heating is done by stoves which heat the air, from what it is in a place where it is done by radiation from fireplaces, it is desirable to keep the source of radiation as low as possible, in order not to waste heat in warming up unnecessarily the layer of hot air which, in ordinary rooms, arranges itself in horizontal layers from about the level of the gas brackets, or the top of the doors, upwards. But where the heating is done, not by radiating heat from an open fire to the body, but by warming up the air of the room itself, the air must be raised to a temperature of from 70° to 80° Fahr., as experience in Germany, Canada, and the States shows, and must be distributed at, or near, this temperature throughout the rooms. The heating, &c., arrangements must in this case then be governed by considerations as to their capacity for effecting this distribution of the air. As to another point, I have frequently experienced the cascade of cold air which is apt to run down the wall of a church. I think it might be got rid of in many cases by running a somewhat broad shelf, or cornice, along the wall, which would shoot it out horizontally at a level of ten or fifteen feet above the floor.

Rev. R. Workman said :—I understand my brother to hold that that the warm and pure air goes up where it is useless, whilst the cold and impure air goes down where it is injurious. Now he endeavours to get the warm pure air down to the bottom, and to draw off the impure air before it, or help the warm pure air to force the impure air out. This certainly seems to be a very reasonable way of dealing with the difficulty, at the same

time I have a doubt as to whether it is not the case that there is also a very considerable amount of impure air rising to the top, and my doubt arises not from the consideration of the philosophy of the thing but from my own experience. Some time ago in my church the pulpit was considerably higher than at present, and it appeared to me that my head, as I went up the pulpit stairs, got gradually into a stratum of not only hot but also impure air which became very oppressive ; and therefore I am inclined to think that, some way or other, there is a considerable amount of bad unwholesome air going up towards the ceiling as well as towards the floor.

Mr. Walter H. Wilson said :—As Mr. Workman began his paper this evening by referring to the ventilation of ships, with the permission of the Chairman, I would like to make a few remarks. I look upon it that the ventilation of houses is a comparatively easy matter to arrange when compared with the ventilation of ships, owing to the size and height of the rooms, the structure being at rest, and nothing in the shape of water to contend with except rain. I ran out a few figures while Mr. Workman was speaking, to give you some idea of the state of the case. The space available for living in, on board ship, is much restricted. The total number of people that could sit in this room is about the number that could be accommodated in the first-class cabins of the "Teutonic." The total quantity of air in cubic feet that the passengers have per head approximately is from 100 to 150. In this room you would have considerably over 250 feet of air for each individual if the room were full. The consequence is, that the changing of the air without causing draughts is a very difficult thing to do. If a fan system of ventilation were fitted, the sectional area of trunkways would have to be considerably larger than the passage through which the passengers go, which could ill be spared from the accommodation for these people. Some mechanical mode for changing the air is almost a necessity. Several systems of ventilation have been adopted. In the

first place, by mere ventilators with swivelling cowl heads, or by fans, and again others by pressure, that is air compressing engines drawing the air from some place where it is dry, and passing it at a considerable pressure through small pipes, which discharge through special nozzles in the ventilators to induce a current of air either in or out. All these have their faults. The last is undoubtedly the best, but it is noisy. In the case of fan ventilation, the risk of having so many water-tight doors where each trunkway passes through the water-tight bulkheads (which in case of collision or emergency would have to be closed) would be very considerable. As to Mr. Workman's point with reference to warming the air, and getting rid of vitiated air, the mode as described by him seems to be the correct principle, except in the case of a very high apartment.

Mr. Gray said:—As to the question of getting rid of vitiated air, we must remember that the vitiated and the pure air will necessarily mix, and the point is;—When you make an arrangement for the heating of rooms in certain seasons and limited to certain conditions, will the same apparatus promote the ventilation of the same apartment under different conditions? Will the arrangements for ventilation in winter answer the same purpose in summer when the air is heated by the temperature outside?

Mr. Conway Scott said:—I was not in at the beginning of the paper, but from what I have heard I think there is a good deal in it. I do not however like the idea of the upper portion of a room being hermetically sealed, and I think difficulty would be felt in hot weather. In any system of ventilation we should look at both the extreme cases, the winter and summer. I like the paper very much, but I cannot express an opinion on the subject at present.

Mr. W. Workman said:—Mr. Conway Scott, I think, misunderstands the theory I have been trying to put forward. If

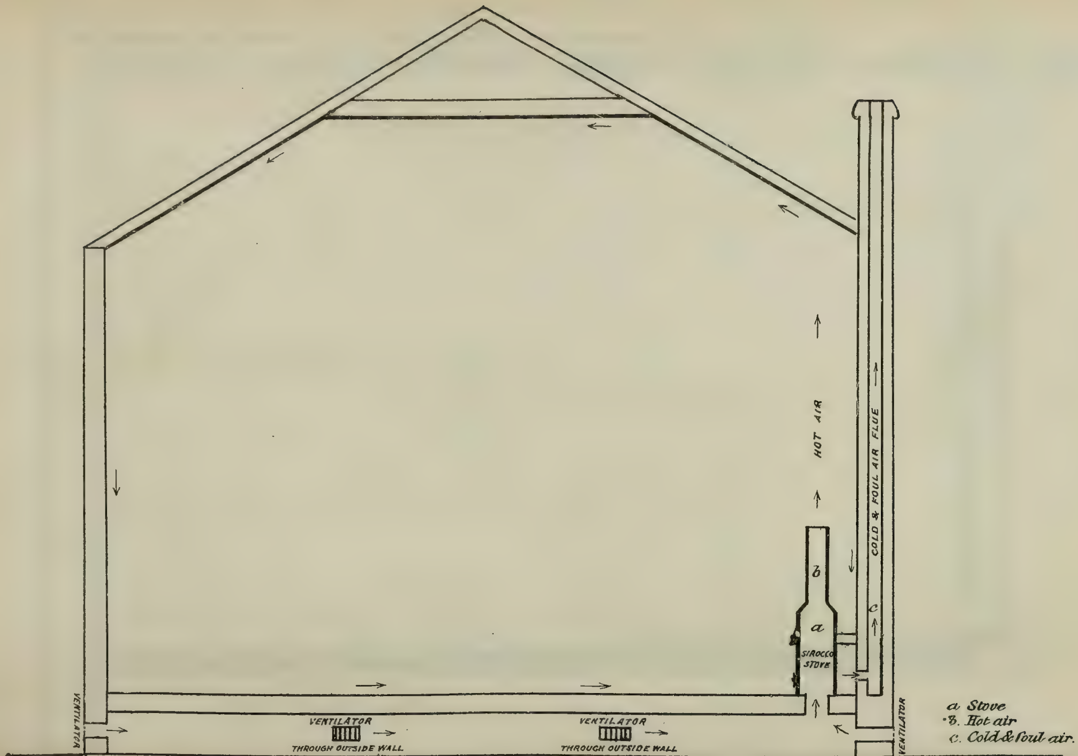
we take a room such as this and heat it with an ordinary stove, we shall get in all parts of it a mixture of foul air of nearly equal impurity; and without an excessive consumption of fuel for heating purposes, which admits of an excessive amount of ventilation in the ordinary way, such as openings in the ceiling for exit and openings near the floor for inlets, this mixture after the first half hour can never be anything else than very impure. It will also be difficult to avoid cold drafts on the audience from the inlets, while an outlet at the floor does not cause a perceptible draft three feet from the opening. Since the winter has passed, it has been found for summer ventilation that fresh air can be admitted near the ceiling, and foul air extracted at the floor, producing good ventilation without discomfort; but this cannot be effected without force to propel the air.

In reply to Mr. Gray, vitiated air and pure air tend to mix, but the mixing takes time. The method advocated in this paper is intended as far as possible to avoid this mixing. There should probably in most cases be two distinct systems of ventilation, one when artificial heat is required, and another when it is not required.

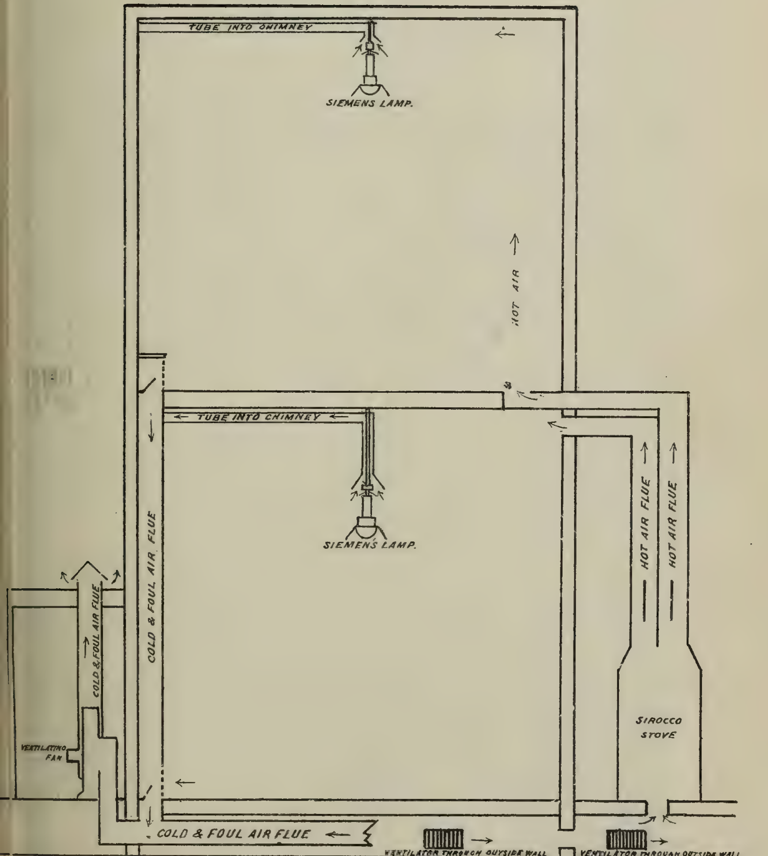
In reply to the Rev. Mr. Workman, if the building is heated by warmed *pure air*, it will ascend and accumulate above, leaving the impure air below. The only way to bring down the pure warm air in this case is to draw off the foul air near the floor level. The effect produced by lowering the pulpit was to increase the capacity of the store of foul air above, carried up by the heat of the burning gas and charged with carbonic acid from its flame, giving a longer time before its bad effects were felt at the now lower level.

The President asked if there was any advantage in the Sirocco Stove. Its outer casing makes it possible without alteration to employ it for drawing in fresh air and heating it. It also produces a large quantity of warm air in a most economical manner. The testing of the Sirocco Stove gives 90 per cent. of the total heat produced by the coal in the air heated.

Section of ideal ventilated chamber



National School Room.



Soldiers' Home, Belfast.

This is easily proved by measuring the relative quantity and heat of the heated air passing through the casing of the stove, and that of the air passing through its furnace and up its chimney. There is no stove that I have heard of to equal it.

This theory of ventilation seems to give the result of pure air with a minimum amount of fresh air introduced. By it a tenth part of the quantity recommended by physiologists to produce a healthy atmosphere will give air sufficiently pure to breathe with comfort. It is not possible to heat by hot air in any way except by heating from the ceiling downwards. No matter how it is tried, the result will be the same.

The next Paper was by P. F. GULBRANSEN, Esq., on

SOME PRACTICAL DIFFICULTIES ABOUT PENDULUMS, AND HOW TO OVERCOME THEM.

The Subject was illustrated by a Barometrical Pendulum.

WITH the advance of science has come the necessity of dividing the day into constantly smaller intervals, thereby causing greater difficulties in constructing clocks keeping record of these small intervals. The best means we possess is the seconds' pendulum. It is generally understood that the oscillations of a pendulum are always of the same duration, but in practice there are formidable obstacles to be overcome. It is impossible to surmount them perfectly, as they are caused by the laws of nature, which govern all motions, and also by the specific properties of the materials we employ. The only thing to be done is to attempt to diminish the effect of these causes;

hence the first necessity is to become intimately acquainted with them.

There are two points in the pendulum which are of importance, the centre of gravity and the centre of oscillation. These two centres are in different positions, and the more distant the more disturbance is produced in the going of the pendulum. Hence to bring them as near each other as possible is to be aimed at. The pendulum is, therefore, made of a slender rod, to which a heavy weight is attached ; but a heavy weight will cause the rod to stretch, and hence a constant tendency to go slow. Next comes the influence of changes in the temperature, to overcome which the gridiron pendulum and the mercurial pendulum have been invented, each of which has its peculiar disadvantages. The regularity of the oscillations of the pendulum is further affected by the density of the atmosphere, so that when the barometer is high the oscillations are of longer duration than when the barometer is low. The amount due to this cause is nearly half a second per day for a barometric change of one inch. To overcome this, Dr. Robinson added a barometric tube to the pendulum rod in different ways ; but, as one of his methods interfered with the corrections for temperature and another would have the effect of increasing the distance between the centres of gravity and oscillation, I have tried in this pendulum to overcome the difficulty by placing a barometer with an independent cistern in the middle of the pendulum. Whether this will give satisfaction, however, must yet be tried.

ROBERT YOUNG, Esq., C.E., then gave some

NOTES ON THE GEOLOGY OF THE EXCAVATIONS FOR THE MAIN DRAINAGE WORKS.

Mr. YOUNG said :—Whilst the high level sewer was being constructed lately, several interesting sections were exposed. At North Queen Street it passed through a very wide basaltic dyke striking nearly north and south, and at the crossing of the Carrickfergus Road the junction of the estuarine bed with the glacial contour of the land was well exposed. The most interesting geological fact, however, which came under my notice was at a point in Millfield where the invert of the six foot diameter sewer was 28 feet under the street level, and where for some considerable distance the tunnel was driven through a bed of coarse clean gravel, whilst at each side it had been carried through the ordinary glacial clay overlying the sandstone which is the bedrock of the district. A short time after this, I passed what seemed to be identically the same gravel being lifted from the foundations of the new quay above the Queen's Bridge, which would be about four feet lower than the gravel bed at Millfield where crossed by the bottom of the sewer. In a hasty examination of this gravel from the Lagan bed, I picked up a wrought and rolled flint.

MR. GRAY said :—Allow me to emphasize what Mr. Young has said with regard to keeping a record of well boring. It was one of the subjects impressed by the British Association upon the representatives of this Society at the last meeting at Leeds. Mr. Young has brought forward and given the result of his own observations, and I am sure we are indebted to him for his very interesting remarks upon this subject. It should be generally known that such records are of the highest value towards the scientific investigation of the sources of water supply.

7th April, 1891.

J. H. Greenhill, Esq., President, in the Chair.

Talbot Baines Reed, Esq., gave a Lecture on

THE FIRST PRINTERS.

The President having briefly introduced the lecturer, Mr. Reed proceeded with his lecture.

After four centuries of investigation, the problem of the invention of printing remains still unsolved. We may trace up the stream very high, but we invariably lose sight of it near the source, and no one is yet in a position to say with authority "when, where, and by whom was found out the unspeakably useful art of printing books."

After insisting upon the clear distinction to be observed between printing in its broadest sense—*i.e.*, the mere process of making a mark by means of impression, and typography—*i.e.*, the process of printing a book by means of movable type—Mr. Reed proceeded to describe some of the early uses made by the ancients of the former art. These are to be found chiefly in the stamped bricks of the Assyrians, and the Chaldean cylinders printed over with cuneiform characters describing historical events. In the absence of any suitable material, such as parchment or paper, which were not invented till a considerably later period, this ancient method of printing was confined to clay, which could be impressed when in a half moist state by the stamps. But among the Romans we meet with seals and stamps evidently intended to be impressed on hard substances like wood or parchment. In all these contrivances, however, the secret of movable type remained undiscovered. Cicero alone, in one of his philosophic conjectures, imagined

the possibilities latent in the letters of the alphabet if separated and used in various combinations. But his generation did not take the hint, and no progress was made till the end of the fourteenth century after Christ, when the Venetians began to produce playing cards and devotional pictures from engraved blocks. In due time, words were engraved along with the pictures, and the block books of the middle ages were produced, each page of which was the impression of a solid wood block. The block books were an advance on anything the world had yet seen in the way of printing, although they were only a development of the immemorial method, and did not admit the new principle of movable types. The lecturer then called attention to one of these block books, the "Speculum," certain editions of which were partly xylographic, and partly printed in movable type. Here then we abruptly find the new art side by side with the old, apparently an accomplished fact before the world suspected its existence. The old art of engraving still survived and served its purpose, but compared with the new art it could express comparatively little, while the letters of the alphabet in infinite combination are capable of expressing every idea the world contains.

Coming now to the vexed question of the invention of typography, Mr. Reed dealt generally with the conflicting claims put forward on behalf of Coster of Haarlem, and of Gutenberg of Mayence. The former depend mainly upon the circumstantial narrative of Hadrian Junius in the sixteenth century, which, though in many ways unsatisfactory, is in other ways strongly confirmed by the existence of a number of anonymous Dutch printed books in the type of the "Speculum," which need to be accounted for before discussing Coster's claims. The earliest known specimens of printing, apart from these debatable works, are the two Letters of Indulgence of 1454, generally allowed to have been printed one by Gutenberg and the other by Peter Schoeffer in the city of Mayence. Mr. Reed dwelt upon the condition of Europe at this critical epoch, and briefly described the manner in which the scribes of the day would be

brought to realise the immense saving of labour likely to arise from the use of types. The earlier mechanical appliances for the production of types were described, and specimens exhibited of the punch matrix-mould used in typefounding. The first books printed by Gutenberg, Schoeffer, and Fust were enumerated, and *fac-similes*, and in some cases actual specimens, of their handiwork displayed. The Mazarin Bible, usually ascribed to Gutenberg, Mr. Reed considered to be the work of Schoeffer, who also, in partnership with Fust, produced the magnificent Mentz Psalter in 1457. Reverting to the invention controversy, the lecturer dwelt upon the testimony of Ulric Zell, of Cologne, who, while giving Gutenberg credit for the invention, admitted that he had received his earliest idea of the art from books printed before his time in Holland, and came to the conclusion that the balance of evidence is, on the whole, in favour of the Dutch claims. The lecturer next dealt with the spread of printing through the different countries of Europe, especially into Italy and France ; and gave illustrations of the style of character adopted by the printers of each country. Finally, the arrival of the art on British soil was described, and an account given of Caxton and the earliest productions of his press.

The lecture was illustrated with numerous specimens of early manuscript books and *fac-similes.*

Mr. Lavens M. Ewart, in proposing a vote of thanks, said :—It gives me the greatest possible pleasure indeed to move that the best thanks of this Society and of this meeting be given to Mr. Reed for his lecture. Every word of it was teeming with instruction, and shewed that Mr. Reed is a complete master of his subject, and has all the information connected with it at his finger ends. We are under a deep debt of gratitude to Mr. Reed for coming to Belfast to deliver this lecture, and it is pleasing that he is not altogether a stranger to us, as he is connected by marriage with the family of our good friend Mr. John Anderson, the Hon. Secretary of the Linen Hall Library, and nearly all of us know the admirable work which Mr.

Anderson has produced on two occasions within the last few years—his list of Belfast printed books. I understand Mr. Reed rendered considerable assistance in getting it up, and I have heard Mr. Anderson speak in high terms of his services in the matter. I have very great pleasure in proposing this vote of thanks.

Mr. Vinycomb said :—I have much pleasure in seconding the vote of thanks to Mr. Reed for his most able and instructive lecture. I should have liked to have heard the subject carried further on from Caxton's time, with something of the history of early printing in England. It would, however, be impossible in a single lecture to tell all that we would wish to know concerning this interesting subject. As to one remark from Mr. Reed with regard to the method of drawing or writing the text in Gothic or black letter characters in the manuscript books before printing was introduced, I have had some little experience of the art of decorative lettering and illuminating, and I am clearly of opinion that such characters were executed with the Reed pen cut at the sides and across the point (like a J pen), and that the peculiar shapes of the letters would be guided by the instrument. The earliest forms of printed letters were adopted from the written characters of the time. The reed pen was afterwards superseded by the quill, with which instrument text writing became less constrained, and finally developed into our modern freehand. And now in their turn steel pens have almost entirely put the grey goose quill to flight. I have great pleasure in seconding the vote of thanks.

Mr. Reed said in reply :—Mr. President, ladies, and gentlemen, —I am very much indebted to you for this kind vote of thanks. I assure you it is a great pleasure to me to find myself at any time in Belfast addressing Belfast men on my favourite subject, because I know that the interest you take in this subject is a genuine one. I think I may say that, outside the metropolis of either of the three kingdoms, there is perhaps no provincial town which has had a more interesting typographical history

than Belfast. There are many men around me who can speak with more authority about Belfast printing than I could ; but I am very glad to think that you have on record such a book as the catalogue of early Belfast books, recently compiled by Mr. John Anderson. If work of this kind were generally taken up at large provincial centres, we should have a great deal of additional light as to provincial printing. If I may add one word more, especially to any printers who may be in this room, I should like to say that I would most heartily commend the study of the works of the early printers to the printers of to-day. I am quite sure that in the productions of the old press we may find many of our most valuable lessons for the excellence of the modern press. I do not mean so much the technical execution ; because, of course, the practice of printing has undergone many revolutions in that way ; but the most important lesson that printers will derive, and cannot help deriving, from the study of early books is, that printing is before everything an art, and that the printer must be an artist. The artist must love his work, and must put something of himself into his work. The greatest calamity which could befall printing would be that it should become a mere trade, and that printers should forget that they are responsible to their generation for maintaining a high ideal of beauty, and for encouraging a holy horror of what is ugly or mean.

If anything I have said this evening has succeeded in interesting you in the study of old typography, I am quite sure that the practice of modern typography will at any rate not suffer by the kind patience with which you have listened to my lecture.

Mr. R. M. Young, B.A., Hon. Secretary, announced the following donations :—A fine specimen of a glass sponge, from Manilla, presented by Dr. J. King Kerr ; and a wooden water pipe, 200 years old, from the rear of the Bank Buildings, presented by Mr. Seaton F. Milligan.

On the motion of Mr. Wm. Gray, seconded by Mr. Jos. Wright, a vote of thanks was passed to the donors.

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OF THE

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Shareholders only are eligible for election on the Council of Management.

MEMBERS.

There are two classes—Ordinary Members, who are expected to read papers, and Visiting Members, who, by joining under the latter title, are understood to intimate that they do not wish to read papers. The Session for Lectures extends from November in one year till May in the succeeding one. Members, Ordinary or Visiting, pay £1 1s. per annum, due 1st November in each year.

Each Shareholder and Member has the right of personal attendance at all meetings of the Society, and of admitting a friend thereto; also of access to the Museum and Library for himself and family, with the privilege of granting admission orders for inspecting the collections to any friend not residing in Belfast.

Any further information can be obtained by application to the Secretary. It is requested that all accounts due by the Society be sent to the Treasurer.

The Museum, College Square North, is open daily from 10 till 4 o'clock. Admission for Strangers, 6d. each. The Curator is in constant attendance, and will take charge of any Donation kindly left for the Museum or Library.

Belfast Natural History and Philosophical Society.

ANNUAL REPORT, 1892.

The Annual Meeting of the Shareholders in this Society was held on 21st June, 1892, in the Museum. Amongst those present were the Rev. John Kingham, Dr. MacCormac, Professor Sheldon, Professor Everett, L. M. Ewart, J.P.; James Thompson, J.P.; R. L. Patterson, J.P.; Thomas Workman, J.P.; Robert Young, C.E.; John H. Greenhill, A. Jackson, James O'Neill, J. J. Murphy, R. Ll. Praeger, Wm. Swanston, John Brown, R. Patterson, E. F. Patterson, H. C. Montgomery, and R. M. Young, B.A., *Hon. Secretary*.

On the motion of Professor Everett, seconded by Mr. Robert Young, Mr. Swanston was called upon to preside.

The Hon. Secretary read the notice convening the meeting, and also the Annual Report, which was as follows :—

"The Council of the Belfast Natural History and Philosophical Society appointed by the Shareholders at the last Annual Meeting on 20th June, 1891, desire to submit their Report of the working of the Society during the past year.

"The ordinary Winter Session was opened on 10th November, 1891, when your President, Professor FitzGerald, C.E., gave an Inaugural Address—subject, 'The Contrast of Practice and Theory.'

"The second meeting was held on 1st December, 1891, when

Mr. Thomas C. Rayner, C.E., lectured on the subject of 'The Manchester Ship Canal Works,' illustrated by a large series of photographic slides.

"The third meeting was held on 5th January, 1892, when Mr. John Lanyon, C.E., described the 'Proposed Belfast City Central Station and Railways,' illustrated by large maps and diagrams.

"The fourth meeting was held on 27th January, 1892, when Mr. L. L. Macassey, Barrister-at-Law, C.E., read a paper on 'The Filtration Works for the Improvement of the Water Supply of Belfast,' illustrated by a series of photographic slides taken by Mr. R. Welch, and diagrams.

"The fifth meeting was held on 2nd February, 1892, when Mr. Seaton F. Milligan, M.R.I.A., lectured on 'The Early Christian Archæology of Ireland,' illustrated by a series of original photographic slides.

"The sixth meeting was held on 24th February, 1892, when Dr. John MacCormac read a paper on 'The Influence of Language and Environment upon the Individual through the Nervous System,' illustrated by a series of photographic slides specially prepared.

"The seventh meeting was held on 1st March, 1892, when Mr. W. Gray, C.E., M.R.I.A., read a paper on 'The Essentials of House Sanitation, and How to Secure Them," illustrated by diagrams, models, and experiments.

"The eighth meeting was held on the 5th April, 1892, when Mr. Allan P. Swan, F.L.S., read a paper on 'Milk and its Ferments, with Remarks on the Caucasian Milk Drinks, Koumiss and Kephir ; their Preparation and Use as a Diet,' illustrated by specially prepared photographic slides, and a microscopic demonstration of some of the milk ferments and moulds living in pure conditions of culture.

"All of these meetings were largely attended, on several occasions inconveniently so. Owing to the death of the Duke of Clarence, the arrangements made by your Council for a series of popular lectures were modified, and two lectures only given

by Professor Sollas, F.R.S., on 'The Making of Ireland Geographically Considered.' "The first lecture was given on 21st March, subject, 'The Limestone Sea'; the second on 23rd March treated of 'The Coal Forests.' Both were largely attended by members. Mr. John Wallace kindly lent his fine lantern and personal assistance to these lectures.

At the request of a large number of members, it was resolved to establish an Engineering Section, which was successfully inaugurated on 23rd December, 1891, when the President of the Section, Mr. Walter H. Wilson, M.I.C.E., gave an Address on the subject of 'Recent Advances in Mechanical Science.' Mr. James Maxton has arranged for abstracts of the valuable papers given at the three meetings already held to be published in the Society's proceedings. The number of Societies holding their meetings in the Museum has been increased by the addition of the Astronomical Society. Further improvements have been made in the Museum, including the readjusment of the principal doors so as to open both ways, a new case for the volunteer relics in the Benn Room, and the rendering of all the remaining cases air-tight. Mr. Wm. Darragh, late senior curator, has been granted a retiring allowance, the proposal to do which was intimated in the last report, and passed at a special meeting. He was also the recipient in October last of a well-merited testimonial, subscribed by a number of the Society's members.

"Your Council have noticed with much regret the decease of three former members, who were connected with the Society for many years. The Lord Bishop of Down and Connor, Rev. W. Reeves, D.D., President R.I.A., retained a warm interest in the Society, dating from 1849, when he gave a lecture, as an honorary member, on 'The Topography of Ireland.' Some years ago he renewed his connection with the Society, and some of the more valuable Irish antiquities bear labels recently written by him. Professor James Thomson, F.R.S., was President of the Society in the years 1862-4, and contributed several papers on the original investigations with which his name will

be always associated. By the death of Canon Grainger, D.D., M.R.I.A , one of our older members, a blank has occurred in our circle not easily to be filled up.

"The Ulster Fauna Committee continues its useful work under its zealous secretaries, Messrs. Robert Patterson and R. Ll. Praeger, B.A., M.R.I.A. Some valuable birds have been added to the Society's collection by their efforts, as will be seen in the accompanying report.

"The Hon. Treasurer has again the pleasure of reporting a satisfactory condition of the Society's finances. The income shows an increase of over £50 beyond that of last season. The items which contributed to this are—entrance fees at Easter and during the session, contributions from other Societies for the use of rooms, the sale of shares, and an increase in the subscriptions from new annual subscribers joining for the sake of the Engineering Section recently inaugurated. Owing to the increase in the items of salary of assistant curator, cleaning Museum, reporting discussions, and providing for the deficit in popular lecture account, there is an increase of about £12 in expenditure, leaving a balance of about £26 in the hands of the Treasurer.

"A list of donations to the Museum and of the exchange publications, received during the year from the various leading Natural History and Philosophical Societies, is subjoined. The donations to the Society call for more than passing notice, as they include a valuable series of the Ray Society's volumes, most kindly presented by Mr. Robert Lloyd Patterson, J.P., F.L.G., and the Volunteer uniform and sword worn by Henry Joy M'Cracken, presented by Mr. Christopher Aitchison, J.P., Loanhead, N.B. The catalogue of the library has at length been printed, and copies sent out to all the members. The Hon. Librarian has arranged that all the books, with a few exceptions of scarce volumes, principally MSS., will be lent out on application. The Council would desire to give their best thanks to the local Press for their admirable reports of the Society's proceedings.

The draft scheme for the government of the Society, as approved at last Annual Meeting, and finally settled between the Commissioners and the Council, will shortly come into operation. Meantime, your Council retire from office as usual, and this meeting will be asked to select fifteen members to form a new Council."

Mr. PRAEGER, one of the secretaries of the Ulster Fauna Committee, submitted their report, as follows :—

"The secretaries of the Ulster Fauna Committee report that their work has steadily progressed during the past year. Several new observers and correspondents have been added to their list, and the letters received almost daily have been answered or acknowledged. A list of Irish freshwater fishes has been compiled and circulated freely amongst anglers and others throughout Ulster, with satisfactory results. The most notable event of the year is the acquisition of the late Mr. Robt. Gage's collection of the birds of Rathlin Island, which has been secured for the Museum through the efforts of the secretaries ; and the donor, Miss Adelaide Gage, deserves the best thanks of the Society for her very valuable gift. There are 153 specimens of Rathlin birds, amongst the most uncommon of which are the following :—A female king eider, the third or fourth Irish example ; a male and a female eider duck, several long-tailed ducks, a fulmar petrel, and glaucous gulls ; while all the characteristic Rathlin birds are represented, such as the raven, the peregrine, the hooded crow, the chough, ducks, geese, and swans. Miss Gage's gift also includes a number of seabirds' eggs obtained on the island. The secretaries have secured several other rare birds for the Museum, such as a pink-footed goose, the first Irish specimen ; glaucous and Iceland gulls, and a black tern. The secretaries would urge on members and others interested in natural history the importance of co-operating with the Committee in their efforts to further the knowledge of the Irish Fauna. All specimens or information

sent to the Belfast Museum will be gratefully received and thankfully acknowledged."

Mr. Brown, *Hon. Treasurer*, in presenting his statement, said :—

"The subscription list is now higher than ever it has been during the existence of the Society—amounting as it does to £149. The income altogether was £332, which showed that we have good reason to be satisfied with the progress of the Society. The expenditure, no doubt, has correspondingly increased. One item was the reporting of the discussions This did not absorb much money, however, and it is of great advantage, and gives a colouring to the meetings."

Mr. R. L. Patterson, in moving the adoption of the Report, first of all handed to the chairman scrip for £400 worth of Shares in the York Street Flax Spinning Company. That represented merely a change of investment—namely, from a 4 per cent. without security to one with security at 4½ per cent. He congratulated the Society on being in such a healthy and prosperous condition—more prosperous than it had ever been within his recollection. The Society was founded in June, 1821, so that it was now in the seventy-first year of its existence. The Museum was established in 1831, which left them sixty years in occupation of the building, the condition of which at present showed that it had been carried out in a most substantial manner. In 1831 the membership was 91, with the population of the city 48,000. The membership was now 254, with the population increased to 270,000. If, therefore, the membership had increased with the population, it should now have been upwards of 500. Among the members there were only 58 annual subscribers—a number which he thought much too small. A great many of the young men of Belfast might reap considerable advantage by joining the Society, which they could do at the small cost of one guinea per annum. The Museum

was free from debt; and he was pleased to know that, besides, there was £26 in hand, so that now the Shareholders possessed a valuable property in a very healthy condition. Having alluded to the deaths of Bishop Reeves, Canon Grainger, and Professor James Thomson, and the loss they had thus sustained, the speaker said he was gratified to observe that the Society contined to receive valuable donations, one of which was before them that day, the birds of Rathlin Island. He could not but remark that their present prosperity was largely due to the indefatigable exertions, the talent, and the tact of their Hon. Secretary, Mr. Young.

Mr. J. H. GREENHILL, in seconding, referred to the Engineering Section, and the good effects it was likely to have on the young men who attended. They were under obligations to the secretaries of the Mechanical and Fauna Sections for their zeal in endeavouring to promote the usefulness of these special departments.

The CHAIRMAN observed that the Report was a most satisfactory one, and showed that the Society was making progress. The character of the papers read during the session was exceedingly high.

The Report was adopted.

The following Members of Council were then elected by ballot:—J. H. Greenhill, John Browne, Professor FitzGerald, W. Swanston, J. Wright, T. Workman, R. M. Young, Professor Everett, Professor Letts, J. J. Murphy, R. L. Patterson, W. H. Patterson, R. Ll. Praeger, J. Wilson, and Robert Young.

Mr. JAMES O'NEILL moved the thanks of the Society to the kind donor of the fine collection of birds of Rathlin Island and other donors during the year. He hoped a great many others would follow the good example and do likewise. The members could do much by directing the sympathies of the public in this direction. The Society had done a great deal in the past by opening the Museum, but with a reserve fund in the bank much more could be done.

Mr. ROBERT YOUNG, in seconding, referred to the gift of a

large block of glaciated limestone from Mr. L. L. Macassey. This was got at the filtration works of the Water Commissioners at Oldpark, and was very valuable.

The motion was passed.

A cordial vote of thanks was passed to the Chairman, on the motion of Dr MacCormac, seconded by the Rev. Mr. Kinghan.

The new Council held a meeting after the conclusion of the Annual Meeting, when the following office-bearers were elected for 1892-93 .—President, Professor M. F. FitzGerald, B.A., C.E.; Vice-Presidents, Messrs. John Brown, W. Swanston, F.G.S. ; J. Wright, F.G.S. ; and R M. Young, B.A., M.R.I.A. ; Hon. Librarian, T. Workman, J.P. ; Hon. Treasurer, John Brown ; Hon. Secretary, R. M. Young, B.A., M.R.I.A.

The Belfast Natural History and Philosophical Society in Account with Hon. Treasurer For the Year ending April 30th, 1892.

Dr. **Cr.**

EXPENDITURE.

	£	s.	d.
To Cash paid Printing Report and Proceedings	£18	13	6
" Printing Library Catalogue	7	0	0
" Guide to Museum	3	19	6
" General Printing and Stationery	10	2	0
" Advertising	13	12	0
" Postage	8	2	7
" Insurance	6	12	0
" Fuel and Gas	20	12	4
" Water Rate	2	4	7
" Cleaning	12	13	0
" Repairs to Curator's House	12	6	11
" General Repairs and Alterations	13	18	10
" New Case for Benn Room	3	14	3
" Expenses at Easter	8	8	3
" Expenses of Engineering Section—Advertising, Printing, Postage, and Stationery	2	18	5
" Deficit on Lecture Account	18	0	2
" Collector's Commission	7	5	3
" Purchase of Shares Bought in	2	0	0
" Adjustment of Interest on Deposit with York Street Spinning Co.	7	6	11
" Subscription to Canon Grainger's Portrait	2	2	0
" Sundries	1	12	8
" Wm. Darragh, Salary and Pension to April 30th	48	0	0
" S. A. Stewart, Salary to April 30th, less one week on leave	49	0	0
" W. Miller, Salary to April 30th	21	12	6
" J. Green, Reporting Discussions	6	15	3
" Rent to April 30th	25	0	0
To Balance	26	4	0
	£359	16	11

RECEIPTS.

	£	s.	d.
By Balance in Hon. Treasurer's hands	£28	2	5
" Subscriptions	147	13	0
" Do. in Arrear	1	10	0
" Donations	11	10	0
" Transfer Fees	0	8	6
" Interest on York Street Spinning Co. Debentures	15	15	0
" Proceeds of 3 Shares sold	21	0	0
" Part Cost of Printing Paper in Proceedings, Refunded	2	0	0
" Half Cost of Fire-Proofing Party Wall Refunded	1	5	5
" Entrance Fees at Door to April 30th	24	6	6
" Do. Easter Monday	37	7	1
" Do. Easter Tuesday	5	8	6
" Contribution from British Medical Society	3	13	6
" Do. Ulster Medical Society	17	2	0
" Do. Naturalists' Field Club	6	6	0
" Do. Society for the Extension of University Teaching	35	6	6
" Do. Ulster Amateur Photographic Society	1	2	6
	£359	16	11
By Balance in Hon. Treasurer's hands	26	4	0

June 7th, 1892. Examined and found correct.

WM. H. PATTERSON, WM. SWANSTON } *Auditors.*

J. BROWN, *Hon. Treasurer.*

DONATIONS TO THE MUSEUM, 1891-92.

From R. Lloyd Patterson, Esq., J.P., F.L.S.

Twenty-eight specimens of stuffed birds, mostly British species; also, skin of a young gannet.

From Robert MacAdam, Esq.

A named collection of post-pliocene fossils, representing forty two species.

From D. Corse Glen, Esq., F.G.S., Glasgow.

A number of minerals and rock specimens from Scotland.

From Edward Hughes, Esq., J.P.

Specimens of minerals from County Antrim.

From John H. Davies, Esq.

Two male specimens of the reed moth (*Nonagria typhæ*) from the "Broad Water," River Lagan.

From Francis Joseph Bigger, Esq.

A viper killed on the Clee Hills, Shropshire.

From J. C. Pinkerton, Esq.

A fresh specimen of the striped wrasse (*Labrus variegatus*), caught at Ardglass.

From Rev. S. A. Brennan, M.A.

Stuffed specimen of striped wrasse, caught at Glenarm.

From Captain Robert Campbell, ship Slieve Donard.

One specimen of the duck-billed platypus (*Ornithorhyncus paradoxus*), from Australia; specimens of garnet rock and sulphur ore, from Alaska; Chinese opium pipe.

From D. C. Campbell, Esq., Londonderry.

A specimen of the pink-footed goose (*Anser brachyrhyncus*), the first certainly ascertained Irish example.

From CHRISTOPHER AITCHISON, Esq., J.P., Loanhead, Midlothian.

Undress volunteer uniform coat of Henry Joy M'Cracken, also his sword and the uniform coat which he wore at the Battle of Antrim on the 7th June, 1798.

From JOHN WILKINSON, Esq.

Specimen of fossil shell (*Productus giganteus*).

From A. M. D. CALWELL, Esq.

A specimen of *Actinoceras giganteus* from Castle Espie, and an ancient stone mortar.

From THOMAS WORKMAN, Esq., J.P.

A number of minerals and shells.

From ROBERT PATTERSON, Esq.

An ancient pewter dish, found in a drain at Antrim.

From GEORGE GORDON, Esq.

Eight bird skins from South Africa.

From A. N. REID, Esq., Ballyshannon.

A stuffed specimen of the black tern (*Hydrocheliden nigra*), shot near Ballyshannon.

From R. LLOYD PRAEGAR, Esq., B.E.

Bones of the Irish elk (*Cervus megaceros*), found in the excavations for the branch dock, Belfast.

From PROFESSOR A. C. HADDEN, Dublin.

Specimen of a shell (*Cassidaria tyrrhena*), recently added to the Irish fauna; also a specimen of *Holuthuria tremula*, dredged in deep water off the south-west of Ireland.

From JOHN BROWN, Esq.

A specimen of the grey phalarope (*Phalaropus fulicarius*).

From W. A. HAMILTON, Esq., J.P., Ballyshannon.

A skin of the glaucous gull (*Larus glaucus*), and a skin of Iceland gull (*L. leucopterus*).

ADDITIONS TO THE LIBRARY, 1st MAY, 1891, TILL 1st MAY, 1892.

ADELAIDE.—Transactions of the Royal Society of South Australia. Vol. 14, part 2, 1891. *The Society.*

BELFAST.—Proceedings of the Belfast Naturalists' Field Club. Ser. 2, vol. 3, part 4, 1890-91. *The Club.*

BERGEN.—Bergens Museums Aarsberetning, 1889. *The Museum.*

BERLIN.—Verhandlungen der Gesellschaft für Erdkunde zu Berlin. Vol. 18, parts 3-10, 1891; and vol. 19, parts 1-3, 1892. *The Society.*

BOLOGNA.—Rendiconto delle Sessioni della R. Accademia delle Scienze dell Instituto di Bologna, Anno 1889-90. *The Academy.*

BOSTON, U.S.A.—Proceedings of the Boston Society of Natural History. Vol. 25, parts 1 and 2, 1891. *The Society.*

BREMEN.—Abhandlungen herausgegeben vom Naturwissenschaftlichen Vereine zu Bremen. Vol. 12, part 1, 1891. *The Society.*

BRESLAU.—Zeitschrift für Entomologie herausgegeben vom Verein für Schlessiche Insektenkunde zu Breslau, part 16, 1891. *The Society.*

BRIGHTON.—Annual Report of the Brighton and Sussex Natural History and Philosophical Society, 1891. *The Society.*

The Antiquity of Man, by S. Laing, 1891. *The Author.*

BRUSSELS.—Bulletin de la Société de Botanique de Belgique. Vol. 29, 1891. *The Society.*

CALCUTTA.—Memoirs of the Geological Survey of India. Vol. 24, part 3, 1891; Records of the Survey, vol. 24, parts 1-4, 1891; and vol. 25, part 1, 1892; Index to the Survey Records, 1868-1887.
The Director of the Survey.

CAMBRIDGE.—Proceedings of the Cambridge Philosophical Society. Vol. 7, part 4, 1891. *The Society.*

The Type Fossils of the Woodwardian Museum, Woods, 1891. *The Museum.*

CAMBRIDGE, U.S A.—Bulletin of the Museum of Comparative Zoology. Vol. 16, no. 10, 1891; vol. 21, nos. 1-5; and vol. 22, nos. 1-4, 1892; also Report of the Curator, 1890 91. *The Museum.*

CARDIFF.—Report and Transactions of the Cardiff Naturalists' Society. Vol. 22, part 2, 1890; and vol. 23, 1891. *The Society.*

Handbook for Cardiff and District, 1891.
The Local Secretaries of the British Association.

CASSEL.—Bericht des Vereines für Naturkunde zu Cassel, 1891.
The Society,

CHERBOURG.—Memoires de la Société Nationale des Sciences Naturelles et Mathematiques de Cherbourg. Vol. 27, 1890. *The Society.*

CHRISTIANIA.—Forhandlinger i Videnskabs Selskabet i Christiania, 1890. *The University.*

DANTZIC.—Schriften der Naturforschenden Gesellschaft in Danzig. New series, vol. 7, part 4, 1891.
The Society.

DUBLIN.—Transactions of the Royal Dublin Society. Ser. 2, vol. 4, parts 6-8, 1890-91. Proceedings, vol. 6, part 10, 1890; and vol. 7, parts 1 and 2, 1891.
The Society.

EDINBURGH.—Transactions and Proceedings of the Botanical Society of Edinburgh. Vol. 18, 1890, and vol. 19 (3 parts), 1891. *The Society.*

EMDEN.—Jahresbericht der Naturforschenden Gesellschaft in Emden, 1889-90. *The Society.*

ESSEX.—The Essex Naturalist, and Journal of Essex Field Club. Vol. 5, nos. 1-11, 1891. *The Club.*

FLORENCE.—Bullettino della Societa Entomologica Italiana. Parts 1 and 2, 1892. *The Society.*

GENOA.—Ateneo Ligure Rassegna Mensile della Societa di Letture e Conversazioni Scientifiche di Genova. Anno 14, 4 parts, 1891. Commemorazione di Jacopo Virgilio, Presidente. *The Society.*

GLASGOW.—Transactions of the Geological Society of Glasgow. Vol. 9, part 1, 1891. *The Society.*

Proceedings of the Philosophical Society of Glasgow. Vol. 22, 1891. *The Society.*

HALLE.—Leopoldina, Amtliches Organ der Deutschen Akademie der Naturforscher, 2 parts, 1890. *The Academy.*

HALIFAX.—Proceedings and Transactions of the Nova Scotian Institute of Natural Science. Vol 7, part 4, 1890. *The Institute.*

HAMBURG.—Abhandlungen aus dem Gebiete der Naturwissenschaften herausgegeben vom Naturwissentschaftlichen Verein in Hambourg. Vol. 11, parts 2-3, 1891. *The Society.*

HERTFORD.—Method for taking Phenological Observations. Mawley, 1891. *The Author.*

IGLO (Austria-Hungary).—Jahrbuch des Ungarischen Karpathen-Vereines, 18th year, 1891. *The Society.*

KHARKOW.—Travaux de la section Medicale de la Société des Sciences Experimentales. 2 parts, 1891.
The Society.

KIEW.—Memoirs of the Society of Naturalists of Kiew. Vol. 10, parts 3-4; vol. 11, parts 1-2, and Appendix, 1890-91. *The Society.*

LA PLATA (Province of Buenos Aires).—Revista Argentina de Historia Natural. Vol. 1, parts 3-6.
The Director.

LAUSANNE.—Bulletin de la Société Vaudoise des Sciences Naturelles. Vol. 27, nos. 103 and 104, 1891; and 105, 1892. *The Society.*

LEIPSIC.—Mitteilungen des Vereins für Erdkunde zu Leipzig, 1890; and Beitrage zur Geographie des Festen Wassers, vol. 1, 1891. *The Society.*

Sitzungsberichte der Naturforschenden Gesellschaft zu Leipzig, 15th and 16th years, 1888-89.
The Society.

LIVERPOOL.—Some Phenomena of the Glacial Epoch by Dr. Ricketts, 1892. *The Author.*

LONDON.—British Association Reports, Leeds, 1890; Cardiff, 1891. *The Association.*

Quarterly Journal of the Geological Society of London. Vol. 47, parts 3-4, 1891; and vol. 48, part 1, 1892; also List of Fellows for 1891.
The Society.

Journal of the Royal Microscopical Society, parts 3-6, 1891; and parts 1-2, 1892. *The Society.*

Transactions of the Zoological Society of London. Vol. 13, parts 1-4, 1891. Proceedings, parts 1-4, 1891; and Index, 1881-90. *The Society.*

MANCHESTER.—Journal of the Manchester Geographical Society. Vol. 6, nos. 10-12, 1890; and vol. 7, nos. 1-6, 1891. *The Society.*

Transactions of the Manchester Geological Society. Vol. 21, parts 7-13, 1891. *The Society.*

Report of the Manchester Museum, Owen's College. *The Curator.*

MELBOURNE.—Proceedings of the Royal Society of Victoria. Vol. 2, part 1, 1891. *The Society.*

MERIDEN, CONN., U.S.A.—Transactions of the Meriden Scientific Association. Vol. 4, 1889-90. *The Association.*

MEXICO.—Anuario del Observatorio Astronomico Nacional de Tacubaya. Ano 12, 1891; and Boletin, vol. 1, Nos. 4-8. *The Director.*

Boletin Mensuel del Observatorio Meteorologico-Magnetico Central de Mexico. Vol. 3, nos. 1-3, 1890. *The Director.*

MILWAUKEE.—Occasional Papers of the Natural History Society of Wisconsin. Vol. 1, no. 3. *The Society.*

MINNEAPOLIS.—Bulletin of the Minnesota Academy of Natural Sciences. Vol. 3, no. 2. *The Academy.*

MONTREAL.—Annual Report of the Geological Survey of Canada, vol. 4, 1890; and Contributions to Canadian Palæontology, vol. 1, part 3, and vol. 3, part 1, 1891; also Canadian Micro-Palæontology, part 3. *The Director of the Survey.*

MOSCOW.—Bulletin of the Imperial Society of Naturalists of Moscow. No. 4, 1890; and nos. 1-3, 1891-2. *The Society.*

NEW YORK.—Annals of the New York Academy of Sciences. Vol. 5, nos. 1-3, 1891. *The Academy.*

Bulletin of the American Geographical Society. Vol. 23, nos. 2-4, 1891; and vol. 24, no. 1, 1892. *The Society.*

ODESSA.—Memoirs of the Society of Naturalists of New Russia. Vols. 12 and 13, and vol. 16, parts 1 and 2, 1887-92. *The Society.*

PADUA.—Atti della Societa Veneto-Trentina di Scienze Naturali in Padova. Vol. 12, fasc. 1, 1891; and Bullettino, vol. 5, no. 1, 1891. *The Society.*

La Nuova Notarisia. Series 2, fasc. 3, 1891. *Dr. De Toni, Proprietor and Editor.*

PHILADELPHIA.—Proceedings of the Philadelphia Academy of Natural Sciences. Parts 2 and 3, 1890; and parts 1-3, 1891. *The Academy.*

Proceedings of the American Philosophical Society. Nos. 96-130, vols. 15-26, 1876-89; and vol. 29, no. 136, 1891; also List of Members, and Catalogue of Library, parts 1-4, 1863-64. *The Society.*

PISA.—Atti della Societa Toscana di Scienze Naturali, Processi Verbali. Vol. 7, 2 parts, 1891; and vol. 8, 2 parts, 1891. *The Society.*

ROME.—Atti della Reale Accademia dei Lincei. Vol. 7, fasc. 7-12, and vol. 7; 2nd semestre, fasc. 1-12, 1891; also vol. 1, n.s. fasc. 1-5, 1892. *The Academy.*

Bollettino della Societa Romana per gli Studi Zoologici. Vol. 1, part 1, 1892. *The Society.*

Rassegna delle Scienze Geologiche in Italia. Ano 1, semestre 1, fasc. 1-4, 1891-92. *The Publisher.*

SAN FRANCISCO.—Proceedings of the Californian Academy of Sciences. Vol. 3, part 1, 1891.
The Academy.

SANTIAGO DE CHILE.—Verhandlungen des Deutschen Wissenschaftlichen Vereins. Vol. 2, part 3, 1891.
The Society.

STAVANGER.—Museum Aarsberetning for 1890.
The Director.

STIRLING.—Transactions of the Natural History and Archæological Society of Stirling, 1889-91.
The Society.

TOKIO.—Mittielungen der Deutschen Gesellschaft für Natur- und Volkerunde Ostasiens in Tokio. Vol. 5, part 46, 1891. *The Society.*

TOPEKA.—Transactions of the Kansas Academy of Science. Vol. 12, part 1, 1889-90. *The Academy.*

TORONTO.—Transactions of the Canadian Institute. Vol. 1, part 2, and vol. 2, part 1, 1891 ; and 4th Annual Report, 1890-91. *The Institute.*

VENICE.—Notarisia Commentario Ficologico. Vol. 7, nos. 24-29, 1891. *The Editor.*

VIENNA.—Verhandlungen der Kaiserlich-Koniglichen Geologischen Reichsanstalt. Nos. 5-18, 1891, and 1-5, 1892. *The Society.*

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BELFAST

NATURAL HISTORY & PHILOSOPHICAL SOCIETY

SESSION 1891-92.

10th November, 1891.

Professor M. F. FitzGerald, B.A., C.E., delivered an Inaugural Address on

THE CONTRAST OF PRACTICE AND THEORY.

In addressing the Belfast Natural History and Philosophical Society on "The Contrast of Practice and Theory" the examples I propose to take in hand are, the design of bridges, beams, roofs, and the like, for one; the steam engine for another ; and some points in the recent development of electrical engineering for a third.

I take beams and bridges first, as being the oldest branch, I suppose, almost, of practical mechanics, since even primitive man, except perhaps a cave dweller, must have used beams of some kind or other in some form or other to carry a roof over his head, or a floor under his feet. Accumulated experience in such matters as ordinary floors and roofs has since long ago been amply sufficient to enable most joists and roof frames to be designed without anybody troubling his head with scientific mechanics at all. When the City Authority makes regulations intended to keep within reasonable limits a propensity for putting the slimmest possible floor joists in the jerriest possible houses that the inspector will pass, it is neither desirable nor necessary to go into elaborate calculations. Similarly, the County Surveyor would not dream of applying all the forces of algebra, calculus, and trigonometry to specify the proportions of a two foot culvert under a country road. Such labour would

be thrown away, inasmuch as the result of the calculations is known in advance by experience, and if any theoretical investigation brought out a different result, that could only be due to a defect in the theory, or an error in the process of reasoning from it.

When, however, advances in other branches of mechanical art, and especially in the manufacture of iron, had introduced new kinds of beams, built up of plates and bars riveted together, the questions that could be solved, in connection with such structures, by theoretical mechanics, increased both in number and importance.

X, Y, and Z, who would make a very poor show if they tried to deal with so complicated a structure as the vaulting and the flying buttresses of Westminster Abbey, found themselves comparatively quite at their ease in a railway lattice girder ; and the necessity, on the one hand, of making such bridges safe, and, on the other, of not wasting expensive material, made it worth while to seek their aid, so far as it could be given. It must, of course, be well understood that, in the details of mechanical theory even in extremely simple things, there is a multitude of questions which the theory of framework, as ordinarily applied, does not touch, or profess to solve in any way.

The preliminary "if" of that theory begins by assuming, in the first instance, that, to all intents and purposes, the girder does not bend, and that no bar or plate in it stretches or squeezes in any way, and that all joints of braces and flanges are points of no sensible size, pinned with microscopically thin pins in perfectly true round frictionless holes. This preliminary "if" then assumes a state of affairs which is, in some ways, most flatly at variance with the real state of matters ; for every real girder does bend, and its joints are not put together with pins or rivets at all comparable in size and accuracy to the pivots a watchmaker puts on the axles of the wheels in a watch. The theory then begins by wilfully assuming a known falsehood to be true.

This sort of false assumption is invariably made whenever

theory deals with practical matters. It may, in fact, be laid down as a general rule for all practical purposes, that a point of contrast between Practice and Theory lies in the fact that Theory always starts with one or more false assumptions about the facts of the case; its preliminary and very first "if" always precedes an untrue statement; and there lies, therefore, behind all its conclusions the practical question, how far does the error of the very first step affect the conclusions drawn later on?

It would be impossible to make use of a quite complete theory which took account of everything—bending, temperature, motion of load, and so forth—all at once everywhere, on account of its frightful complexity. In theory, therefore, we begin by leaving a great number of things out of account; and we take a limited set of causes, as if they were the only causes in operation; whereas in practice everything is sure to come into account some way, and every cause sure to produce its effect in due proportion. In theory we treat all the things and causes that we are taking account of as equally important till we have calculated their results; in practice it is only necessary to be able to attain some particular results, and all others may be neglected, no matter how intimately they may be connected in theory with the rest. A curious case of this sort occurs in questions as to the strength of pillars. It might appear at first sight that, except for the difference between crushing and tearing strength, a straight pillar ought, in theory, to bear compression, by a load on its top, just as well as tension; and that the theory of frames, such as the lattice girder, should be just as independent of the theory of elastic bending in regard to struts as it is in regard to ties. It is well known, however, that, except for very short pillars, the load that will break a pillar or strut is less than what will crush the material of the pillar. Consequently the sizes of struts in the lattice girder have to be calculated by a different rule from that used for ties, and designed in a different way. This peculiarity of struts is explained by showing, from the theory of bending, that a tall pillar can, when loaded to a

point far below its crushing limit, get into an unstable state in respect of bending over and doubling up, even when firmly bolted down to a fixed base, on the smallest provocation. The importance, therefore, of the invariable existence in practice of some small crookedness in every bar, differs greatly for bars in tension and bars in compression. For most theoretical and practical purposes all, even the minutest, crookednesses are of nearly equal and great importance in pillars, and of unequal, but extremely small, importance in tie rods.

The principal use of theory in bridge work is, of course, that it enables us to dispense with experiments. It would for instance be impossible by a process of trial and error on full size models to design such a thing as the Forth Bridge, or even much smaller structures. If the theoretical mechanics of framework had not been carefully worked out, the construction of many structures of no unusual size would have been impossible, not because it was forbidden by the nature of things, but because nobody could have told the right proportions for important parts. Practice often fails to distinguish clearly between what cannot be made for want of materials and tools, and what must not be attempted because the thing would break down. Theory can generally distinguish between these.

Coming now to my second instance, the steam engine, we shall find a very different relation between Practice and Theory from that existing in the case of beams and girders. After James Watt's discoveries and inventions, and his reduction of the method of designing the parts to an orderly one in place of the blind, haphazard sort of way previously existing, the principal improvements came through increased skill in manufacture, and increased accuracy arising from the use of machine tools. Meantime, during the second quarter of the present century especially, a great advance, from a scientific point of view, had been made by the labours of Carnot, Joule, Clausins, and others in the explanation of how heat, supplied by the furnace to the boiler, becomes converted into work in steam and other heat engines. An extension of our powers of dealing with this con-

version of heat into work in a practical way might therefore naturally be expected as the result of the advance that theoretical thermodynamics had made, corresponding to the advance in our power of building bridges and other structures, resulting from advances in the theory of strains.

Among the widest and most far-reaching of the results established by Carnot's and Joule's researches two stood out pre-eminent, and seemed specially well adapted for practical application. One was the familiar law of Joule telling us how to measure heat by an equivalent quantity of work. The other was Carnot's, which declared that not all the heat supplied to an engine could be converted into work, but only a certain proportion, and that this proportion was fixed by a very simple relation between the highest and lowest temperatures of the steam or other vapour used in the engine.

The temperatures of boiler and condenser are things easily ascertained, and the whole heat supply can be found without any great difficulty; consequently one would naturally jump eagerly at a pair of great overriding rules, such as those given by the laws of Joule and Carnot, which appeared to save all trouble about calculating details, and to arrive directly at the desired result of finding how much steam of a given pressure would be required to give, in an engine, a certain return in the form of work.

Carnot's law, for instance, states in effect that if you want twenty pounds worth of work out of steam in a locomotive with 180 lbs. pressure per square inch, you must supply no less than about a hundred pounds worth of work in the form of heat to the boiler. The rule for making the calculations is well known, and so simple that anyone can apply it.

Joule's and Carnot's laws were therefore applied over and over again both by theorists and practical men to the case of the steam engine, and always brought out grossly erroneous results. Nevertheless these laws are certainly true, though it is also certainly true that no law of nature ever fails to work out its own arithmetic correctly. Much doubt and difficulty

arose, and arises every day almost, from the glaring and obvious discrepancy between the heat supply required by Carnot's law for an engine and that really necessary, the latter varying from somewhat over twice to fifteen or twenty times the former, in different engines. Yet in spite of this discrepancy between the results of Practice and those of Theory no tolerably good reason can be given for doubting either Joule's experiments or Carnot's law, though the discrepancy is so great as at first sight to appear a flat and emphatic contradiction by facts of the whole of modern thermodynamical theory from beginning to end. There are other discrepancies too. Carnot's law says that the hotter the boiler steam, the more economical in fuel will the engine be. In addition it says that using naphtha vapour, or mercury vapour, or a mixture of gas and air, or anything else makes no difference. Forty or fifty years ago, however, many people had serious doubts as to whether fifty pound steam was a bit more economical than fifteen. Later on, gas engines, it is true, gave some countenance to Carnot's law, for the temperature of explosion in them is very high; but then naptha and ammonia engines contradicted it, for in them the boiler temperature may be, with equally economical results, much lower than in a steam engine using the same pressure.

Now, what is anyone to think of all this? Joule's experiments have been confirmed in a multitude of ways over and over again. Carnot's law is closely connected with the rule that perpetual motion is a practical impossibility; and yet the results got by their application to the case of the steam and other heat engines seem to be, on the face of the thing, totally at variance with all the known facts.

I have chosen this example because it is a very conspicuous one of the consequences of not carefully attending to what it is that a theoretical rule does not say, and fixing one's attention wholly on what it does say. I will repeat the rule, as I gave it applied to the case of 180 lbs. steam before :—

"If you want twenty pounds worth of work out of steam in the engine, you must supply not less than about a hundred pounds worth of work in the form of heat to the boiler."

Now, pay attention to the fact that a theoretical rule is apt to mean exactly what it says explicitly and no more. Listen again to one part of it :—

"You must supply no less than a hundred pounds worth."

Therefore, the rule says nothing whatever about how much more than a hundred pounds worth you may perhaps find it necessary to supply. And, moreover, it so happens that it gives practically no assistance in estimating whether, in any actual engine, the excess will be great or small. We can indeed specify the conditions under which there will be no excess ; but then they, like all exact theoretical conditions, are unattainable in practice, and we have seen in the case of the pillars that an extremely small deviation from exact theoretical conditions may lead to very large consequences, having no very direct relation to the largeness or smallness of the deviation itself.

I shall endeavour to illustrate by an example the sort of leap in the dark that is taken when an attempt is made to explain the losses of heat beyond a certain point, in a heat engine, by seeking assistance from the laws of Joule and Carnot. Suppose we had a tank on the top of a hill with a pipe leading to a small water motor, which drove the brushes in a hairdresser's shop for instance. Suppose moreover that, instead of a natural supply to the tank, we had to drive the motor by pumping back the water to the top of the hill. Then suppose we got a man to work the pump, and told him that he had to pump up at least twenty gallons, which is about six or seven bucketfuls, for every customer's hair brushed, and explained to him how this was the exact quantity necessary, after making due allowance for the efficiency of the water engine, to give the power required to drive the brush. Then suppose, when he came to do the pumping, he found it necessary to pump a hundred and fifty gallons or so instead of twenty, or else the tank would run dry, he would naturally be disappointed, and probably would infer that the rules for calculating the power of a fall by the height and discharge were fundamentally wrong. It would be no comfort to him if we, with our heads full of the beauty of the

method for calculating the power of a fall from the height and discharge, entered into elaborate explanations of how it would make no difference if instead of water we used one thirteenth or fourteenth of the same amount of mercury, or twenty per cent. more paraffin oil, to get the same power out of the same fall. He would persist in believing that our rules and calculations about power and fall were all wrong, until he discovered that we had only told him he must pump twenty gallons to support the motor, and forgotten all about six or seven other pipes which led from the tank on the hill down to the sump hole his pump drew from, and were running full bore all the time. Of course it would then be clear that the rules for calculating the twenty gallons might be right enough, but that he had to pump not only them, but all the water that came by the other pipes as well.

The theory of steam and other heat engines is, as it happens, full of the most harassing and troublesome "ifs" at every turn; and not only that, but when a preliminary statement of facts, allowed to be perhaps not too false or incomplete, has been adopted, there are all sorts of troubles and difficulties in the mere process of evolving the conclusions which follow. Small, or what might at first sight appear small, variations in the list of facts and causes taken account of, lead to considerable variations in the consequences, so that very little advantage can be got from thermodynamical considerations in steam engine design, compared to the advantages, in the way of dispensing with experiment, gained from the theory of stresses in designing girders and beams.

Passing now to the last instance I am taking, which is the application of electricity on a large scale, the relations of Practice and Theory are again different from those in both of the other cases.

In this case the purely scientific and theoretical side of the question rested on a much more ample and firm foundation, long before dynamos on any commercial scale were introduced, than either thermodynamics or the theory of stresses did when

the steam engine and iron structures began to be used extensively.

X, Y, and Z had been well tethered to the laboratory experiments ; indeed, some branches of pure mathematics may be almost described as invented for that very purpose. Electricity had been extensively used in the telegraph, though the power (measured in steam engine horse power) was minute, and many of the smaller practical questions connected with the construction and use of commercial, as distinguished from scientific, instruments, had been worked out in consequence.

It is not difficult to imagine that where the theory, meaning thereby the process of evolving conclusions from an assumed set of facts, was such as to have even led to the invention of special mathematical methods of dealing with the facts, the conclusions, though really involved in the data, would not be at all obvious to any one who had no idea of how to reason about them. It had been found, besides, that the false and imperfect assumptions always made before trying to estimate from theory the results to be expected in practice, usually led to errors of no great importance. Even in the early days of dynamos, a return of over 80 per cent. of the work expended was obtainable in the form of electrical energy ; and, in respect of the loss, much of it could be accounted for by the application of the same rules as those by which the useful work was calculated. The same rule which calculates the useful work expended in overcoming the resistance of a set of glow lamps, serves to calculate much of the loss incurred by resistance of the conducting wires, armature, and so forth. Nothing like this occurs in the steam engine ; for the rule for expenditure of heat necessary (at the least) to turn out a certain horse power gives no assistance in calculating the loss by radiation from the boiler, friction in the pipes, initial condensation, &c.

The typical practical man who never knows anything, in the least out of the way, about why or how consequences follow when drawn by unaccustomed methods, was at a loss in dealing with electrical machinery ; and his most valuable qualities, his

keen eye for the false and imperfect assumptions of theory, and his ability to allow for, or detect them and their consequences, had only a limited range of usefulness. He did not feel as if he knew how to see through the questions before him, and even where he did, the two or three per cent. advantage to be gained thereby seemed no great thing. As electrical engineering practice, however, extends, the number of persons who have got more or less accustomed to the way of handling the questions that arise increases, and the importance in practice of those things which are left out of account in theory increases.

As long as dynamos were toys, details about the way the wires were fixed on the armature, what composition of brass or bronze was used for the commutator bars, what precise construction and arrangement of switches, &c., was most convenient, and so forth, were unconsidered trifles. These things never come into the theory from a scientific point of view at all ; but they have all become matters of practical importance.

The case, however, of many of these questions is very different from what might be called somewhat parallel questions in the case of a steam engine, in that, with regard to several of them, theory has often a say in the choice of means to be adopted in overcoming difficulties. Heating in certain parts of a dynamo, such as the armature and horns of field magnets, can for instance be overcome either by a circulation of cold air or water, or by adopting particular ways of constructing those parts : theory in these cases, by affording a choice of means, pointed out those to be adopted in practice.

The aid to be got from theory is, however, unequal in different matters. For instance, with alternating systems of very high pressure it was found that materials which prevented the passage of electricity for a short time pretty well, broke down after a while. It was as if the insulation of the conductors was unable to stand perpetual jarring ; and special insulating compounds have therefore to be sought out, just as special qualities of iron or steel have to be used in particular parts of ordinary machinery, selected on account not only of their strength, but of their durability and reliability as well.

The number of practical questions incapable of being all taken into account together in any reasonably simple theory tends therefore to increase continually; but the great difference between the use, as a guide to a fairly accurate preliminary estimate of results, of the theory of electricity, remains in strong contrast to the practical impossibility of attaining any similarly accurate results by any equally simple and direct methods in the case of the heat engines in ordinary use.

It has been pointed out that Theory is no guide in regard to a great many of the practical consequences which follow either from a correct or incorrect application of it. Consequently it cannot be held to be true as a universal principle, that to be able to deduce correctly the direct consequences of any theory, no matter how true, is a sure way of avoiding errors. It has been pointed out that theory in the case of the mechanics of framework, of beams, and of girders is directly useful in so far as it enables us to dispense with experiment, more especially with experiments on a large and expensive scale. In addition, as in the case of struts and ties in framework, the theory of the design of the framework as a whole may be obscured by the necessity for taking account, in designing one part, of the small practical deviations from the exact theoretical data, when similar deviations may be left out of account in other parts. It is therefore necessary, in order to understand the results, to know when minute deviations from assumed conditions are of great importance, and when they are not.

It has been pointed out that sometimes theory only sets a limit, as in the case of steam engine work, of such a nature that outside that limit the rules of calculation are totally unlike those by which the limit itself is fixed ; and it is more important for practical purposes to know what the theory leaves out of account than what it takes into account, in judging of the value of theoretical conclusions. Therefore it is often more necessary to know what the precise data of theory are not, than what they are ; and more important to see clearly what things a certain theoretical principle does not determine, than

to be able to follow out its consequences in the things it does determine. This is particularly likely to be the case where a choice must be made among different sets of data, selected among the same set of facts, for our starting point of theoretical deduction.

It has been pointed ont that where, as in electrical machinery, one set of theoretical rules governs the great body of results, leaving comparatively small outstanding differences, much more confidence is likely to be placed in theoretical calculations than where the reverse holds good, as in the case of the steam engine ; and here ability to follow out the consequences which flow from assumed data comes into play, enabling experiment to be dispensed with, as in the case of bridge design, to a considerable extent. At the same time, increase in the scale on which operations are carried on introduces always, more or less, new practical questions, some capable and some incapable of being settled, or put in the way of settlement, by theory. In such a subject as this, then, it is desirable to understand the method of reasoning to be employed, in its general features at least, in order to be able to see what choice of means can be suggested by theory, from which in practice that best suited to the special circumstances of each case may be selected.

The line of thought I have taken up leads, in a general way, to looking at Practice as something wherein all the facts of a case are known, down to the minutest microscopic particular, and every possible consequence of every possible influence works itself out in due proportion ; while Theory always, and unavoidably, starts with facts more or less wrong, and data consisting of a selection only, generally a very small one, of the real circumstances, with only a few of the consequences completely followed out, and the rest either ignored altogether, roughly guessed at, or merely fixed as lying within certain limits.

Improvements in Practice resulting from theoretical considerations are, from this point of view, best insured by a careful examination of the points that the existing theory leaves out of account. The importance of knowing how to follow out the

consequences of theory, that is, the power to answer what are equivalent to examination paper questions, is of value mainly in proportion to the degree in which a fairly simple theory is able to deal with practical data ; and in most practical matters a moderate, very moderate, acquaintance with such processes of deduction, if combined with a careful and strict attention to the questions, What are the real data, neither more nor less, assumed ? and, What sort of consequences can be deduced from those data, neither more nor less ? is what is really necessary to clear the ground, and enable us to judge in what direction to look for the sources of the inevitable contrast between Practice and Theory.

The HONORARY SECRETARY (Mr. Robert M. Young, B.A.) announced to the meeting that Mr. Robert Lloyd Patterson, J.P., F.L.S., had given to the Society a very large number of the valuable publications of the Royal Society, London. He had also presented them with about forty fine specimens of native birds.

1st December, 1891.

Professor M. F. FitzGerald, B.A., C.E., in the Chair.

T. C. Rayner, Esq., A.M.I.C.E., read a Paper entitled

THE MANCHESTER SHIP CANAL WORKS.

Mr. Rayner, who was received with applause, said the Manchester Ship Canal was an enterprise of such exceptional magnitude that it had naturally excited more than usual interest in the public mind, not only in the United Kingdom, but, he might almost say, throughout the civilised world. The densely populated manufacturing district, of which Manchester was the metropolis, was on the eve of undergoing a great change, the importance of which it was almost impossible to estimate. Shortly, a population of more than 7,000,000 (one-fifth of the whole inhabitants of the United Kingdom) would have a nearer ocean steamer port than they now possessed. The district affected by the ship canal embraced more than one hundred and fifty industrial towns, one hundred of which had a population exceeding 10,000, and eleven exceeded 100,000, including Manchester and its suburbs, with a population of 850,000. The boundary of this area included 7,500 square miles, and the density of population within a triangle drawn inside this, was about 5,414 per square mile, being thirteen times as great as the density per square mile in Belgium and Holland, usually considered to be the most densely populated countries in Europe, and nineteen times as great as that in the rest of the area of the United Kingdom.

Having been engaged himself on the ship canal works for several years, he could speak from personal knowledge of a good deal of what he would refer to that evening. The city of Man-

chester had for many years longed for better access to the sea, and in 1825 application was made to Parliament for powers to construct a ship canal from the mouth of the River Dee, on the Flintshire side, to Manchester. The project met with the most determined opposition, and the bill was thrown out. At a conversazione held at Manchester in January, 1841, convened for the discussion of the improvement of the Mersey and Irwell navigation, a letter was read from the late Sir William Fairbairn. In this letter Sir William made the following prediction, which had every prospect of fulfilment :—"I would earnestly recommend the public to encourage a more searching inquiry into the subject. It is one of deep interest to the community, and any improvement which will enable ocean-going vessels to discharge their cargoes in a commodious wet dock in Manchester would form an epoch of such magnitude as would quadruple her population, and render her the first as well as the most enterprising city in Europe." There could be no doubt that this eloquent description of the potentiality of a capacious waterway between the sea and Manchester did much to kindle the enthusiasm of the public. After narrating the history of the inception of the undertaking, the lecturer went on to say that the point selected for the entrance to the canal proper from the tideway was at Eastham, the channel at which point was now being dredged to a depth of about forty feet below high-water spring tides. As the land rose about seventy feet from the shore of the Mersey estuary up to Manchester, the canal had to be constructed in sections, forming level reaches at different levels, separated by locks, through which the change of level would be accomplished.

The total length of the canal, from its commencement at Eastham up to its termination at the Manchester and Salford docks, was thirty-five and a half miles, divided into reaches of very different lengths. The various reaches were described by the lecturer, who said that vessels would rise sixty and a half feet in passing the four sets of locks from the tidal reach below Latchford to the locks at Manchester. Above

Latchford the canal became virtually a canalised river, as it would be the waters of the Rivers Mersey and Irwell, and other smaller streams, that would fill it. It had been contended that the water supply might sometimes be insufficient ; but means had been adopted to cope with such a contingency arising in a dry summer. It took a good deal of water to fill a lock 600 feet long by 80 feet wide. Alongside therefore of this lock there was a second lock 350 feet long by 50 feet wide—and in the case of Eastham only, a third lock 150 feet long by 30 feet—and there are two sluice-ways on the land side of the locks, each 20 feet in width, and closed by counter-balanced sluice gates, moving vertically on free rollers, whereby friction was reduced to a minimum, so that they were very easily raised against a head of water. Mr. Rayner proceeded to give an exhaustive and interesting description of the locks and gates, river walls, enclosing embayments, gantries, and the Ince light-house ;—the River Weaver and sluices ;—the water supply, railway deviations, various modes of excavating, and inundations.

Speaking of recent developments and progress, he said the work had been carried on with energy, particularly at the Eastham end. At the end of June last this section was completed and ready to receive the tidal water. The tide was not however admitted, as most people imagined it would have been, at the Eastham locks, but three and a half miles higher up, near Ellesmere Port, and the operation was carried on gradually. First a small gap was made in the dam, which was of hard clay, and this was gradually extended. When the tide rose and reached the gap it ran first over a shelf of clay, and leaped a sheer twenty feet below and hastened towards Eastham. Some water had been let into the canal previously.

The advantages of the canal having been indicated, Mr. Rayner made a few observations on its geological features. The oldest group of rocks cut through by the canal was that to which the name of trias was given. The triassic rocks were for the most part of a bright red colour, and consisted of sandstone, marls, and consolidated gravels. There was no doubt

that at one time there existed a Lancashire Dead Sea. Where the triassic rocks were being deposited the scene presented to the imagination was a great salt lake, in the midst of an arid desert, with a scant and stinted vegetation. Little in the way of living creatures was to be seen ; but the waters were at times frequented by strange amphibious monsters, who crawled across the sand banks and left queer footprints, to be preserved to our days. It had been a source of surprise and disappointment to the geologists of Manchester that in the magnificent sections opened up to their study, so few relics of man, of his handiwork, or of the extinct animals who disputed with him the sovereignty of the woods and fields, had been brought to light. One reason why so little had been found was that the Irwell valley, below Manchester, is a very wide one, and the windings of the river, though very complicated, yet are in the main confined to the central part of the valley, where only the more recent of the river deposits are accumulated, the older ones occurring as terraces or plateaux near to the boundary hills, and consequently away from the line of the ship canal.

In concluding, the lecturer remarked that, as had been happily expressed by an eminent living citizen of Manchester, Mr. Alderman Bailey—"There never will be a better opportunity than the present for the scientific and archæological student to read the story of the rocks in the cuttings of the Ship Canal. The gradual formation of the stone, the ancient strands of sand, the old lagoons formed on the sites of the prehistoric forests, the fossils, the boulder clay, all in view, are rich with suggestive matter to the students of the knowledge of causes. Nature sometimes makes rock in a clumsy fashion ;—the mountain stream picks up and holds in solution sulphate and carbonate of lime and magnesia, silica, and other mineral particles, and deposits these among the sand in the valley below, sometimes in wrong proportions, and often in the wrong place. In the crucible of time the ingredients mix together and harden, and become building stone, which is used by man. We see nearly the same process going on in the way that artificial stone is

made in the various concrete walls that are being erected by the contractor, but in these concrete works the exact amount of lime and the exact amount of sand, with a proper quantity of water, are mixed together, and an artificial stone is made, in many cases far superior to that formed by dull nature ;—and thus we see how chemical science aids man, who uses the dust-bin of nature to make hard stone walls that increase in hardness with age, and are superior to quarried stone for many purposes of construction. I think I have been more impressed with the splendid concrete work of the contractor, than with any other evidence of his great work as a captain of industry. Indeed, the whole work is a triumph of the discipline of force."

Mr. Jaffé moved a vote of thanks to the reader.

Professor Everett—I have very great pleasure in seconding this motion. The lecture gives us an intense respect for the men who engage in these vast campaigns against the brute forces of nature. I consider this a much better way of spending millions of money than spending £8,00,0000 in fighting the Abyssinians, or £15,000,000 in fighting the Afghans. We get a result which will be permanently useful, and which will tend to unite men in closer bonds instead of making them enemies. I think we could not have had the condition of the works, and the operations that have had to be performed, more clearly placed before us than they have been placed this evening.

Professor FitzGerald—Mr. Jaffé has moved and Professor Everett has seconded a vote of thanks to Mr. Rayner for the extremely able paper he has given us on the subject of the Manchester Ship Canal, and I think that no words of mine are necessary in order to strengthen your impression of the value of such a picturesque and powerful account of that work. I think with Mr. Jaffé that it is hardly possible but that the result with the Manchester Ship Canal will be very much the same as with the Suez Canal, so that I should be less surprised at the Manchester Ship Canal being found in the course of the next 20 years to be only about half as large as was necessary

than to find that it was larger than necessary. I think I need hardly do more than put the vote of thanks to the meeting, and request you to pass it by acclamation.

Mr. RAYNER said in reply—I am much obliged for the very kind, but too flattering, manner in which Mr. Jaffé has just proposed this vote of thanks to myself, and to you, ladies and gentlemen, for the very cordial manner in which you have responded. I assure you it has afforded me very much pleasure to have addressed you on the subject I have attempted to deal with this evening, and I am gratified to have had such an influential, indulgent, and appreciative audience.

5th January, 1892.

Professor M. F. FitzGerald, B.A., C.E., in the Chair.

John Lanyon, Esq., C.E., gave a lecture on

THE PROPOSED BELFAST CENTRAL STATION AND RAILWAYS.

Mr. Lanyon commenced his lecture by recounting the different steps that had been taken in Ireland to facilitate mail and passenger and goods communication, with special reference to the communication between Dublin and Belfast; the first regular communication between these two places being by stage coach, which performed the journey in the very good time of twelve hours. In 1842 the line of railway from Belfast to Portadown was commenced ; in 1844 Dublin was connected by rail with that portion of Drogheda which lies on the south side of the River Boyne ; in 1845 powers were obtained to make a line from Drogheda on the north side of the Boyne to Newry, with a branch line to Portadown, and subsequently the erection of the Boyne Viaduct completed the through line of railway between Belfast and Dublin. Up till very recently there was in Dublin a break very similar to that which now exists in Belfast. This has been to a great extent obliterated by the loop-line between the Great Northern and the Dublin, Wicklow, and Wexford Railways, and will be further cured by the communication that will shortly be finished with the Great Southern and Western Railway by a tunnel under the Phœnix Park; and it is only a question of time when this communication shall be made good to the Midland Great Western Railway.

The lecturer then proceeded to explain the proposed scheme, the objects of which he stated to be the uniting in one central

station close to Castle Place and Royal Avenue, which are practically the centre and heart of the city, of the railways which at present have their termini in Belfast—viz., the Great Northern Railway, the Belfast and Northern Counties Railway, and the Belfast and County Down Railway—and the supplying, in connection with the station, of a first-class hotel. Mr. Lanyon proceeded to point out the necessity which, in the opinion of the promoters of the new undertaking and in that of a very large section of the public, exists for both of these branches of the undertaking, the present termini being not only quite insufficient for the present traffic, which is increasing rapidly, but also inconveniently situated, especially those of the County Down and Northern Counties Companies; the County Down terminus lying on the south side of the River Lagan, and necessitating, for the great bulk of its passengers, the crossing of the Queen's Bridge or the ferry in order to reach it; often an unpleasant task, especially in severe weather. The proposed central station will occupy about nine and a half acres, and the station and new streets and approaches will occupy nearly twelve acres, and will be quite close to Castle Place, Royal Avenue, and the General Post Office, with which building a direct communication will be made, thus accelerating very considerably the delivery of letters and parcels from all lines of railway and from the steamers, as well as saving a corresponding amount of time in their despatch. This central station will be at a low level—the platform about fifteen feet below the surface of the streets—and the lines will be brought into it as follows:—The Great Northern Railway—through vacant ground the property of that company, then under Durham Street, Glengall Street, College Street South, Murray's Terrace, and by an open cutting through the intervening spaces and the space in front of the Belfast Academical Institution, and under College Square East into the central station. This section will have a wayside station alongside the present Great Northern terminus. The Belfast and Northern Counties Railway—through the property of that company, and under Whitla Street and Back Ship Street, and then

in a subway under York Street and Royal Avenue, and into the central station. This section will have a low-level wayside station where the present York Road terminus is. The Belfast and County Down Railway—through ground the property of that company, then in a subway and tunnels under Queen's Quay, the Lagan river, Custom-House Square, Waring Street, Rosemary Street, Royal Avenue, and Berry Street, and into the central station.

With reference to this last section, which appears to be the most interesting one, the lecturer stated that it is at present under consideration whether it could not be easily arranged with the Belfast and County Down Company that passengers desiring to be carried to and to start from the old terminus, might be provided for by dividing incoming trains at Ballymacarrett junction, the point where the new line will strike the existing one, sending one portion of the trains on to the central station, and the other into the present terminus, and similarly uniting outgoing trains from the present terminus and central station at the same point. The lecturer went on to describe the harbour station of the proposed railways. This station will be worked in connection with the cross-channel steamers. It will be so constructed as probably to supersede the ferry service at that part of the river, for it is intended to make it one continuous station, with platforms, from quay wall to quay wall, underneath the river. Large passenger lifts, similar to those in use at the Mersey Tunnel and the London and South City Suburban Railway, will be provided at each end of this station, and foot passengers who wish to cross under the river will thus be accommodated. Then it is suggested that there should be either an elevated gallery or a subway for passengers, running along both Donegall Quay and Queen's Quay at right angles to, and connected with, the proposed harbour station. These galleries or subways will have means of access opposite the berth of each steamer, and this arrangement will doubtless be found of great convenience. A subway or gallery along Queen's Quay will be necessary, as well as along Donegall Quay; for it is

understood to be in contemplation to transfer to that quay the berths of some of the cross-channel steamers. Arrangements will thus be perfected for carrying passengers through from the central station, and from all the railways running into it, to the cross-channel steamers and *vice versa*, and for the transfer of their luggage from trains to steamers, and from steamers to trains.

By reference to the maps, plans, and diagrams exhibited, the lecturer demonstrated the mode of construction of the proposed tunnels and subways. The tunnel from the central station to the harbour station under the river will be formed of two cast-iron tubes, put into position by means of a shield that will be forced forward under Berry Street, Rosemary Street, Waring Street, and Albert Square. This mode of construction will entirely prevent the extraction of moisture from the subsoil, and, therefore, will not in any way endanger the streets or the buildings on either side of them during the progress of the works by sinking or subsidence. The harbour station will be constructed under the river by means of a coffer dam, and as it will be in solid clay for more than half its height, there will be no difficulty in constructing it absolutely safe and watertight, all the work being executed in open cutting. The subway connecting the Northern Counties line with the central station will be formed of concrete between waterproof sheet piling, which will prevent any danger of injury to the streets or houses; it will be "cut and cover" work. The Great Northern Railway connection will be altogether open cutting, except where streets cross over it by bridges. The ventilation and lighting of the whole system has been most carefully worked out; the main station will be ventilated by means of top ventilators in the roof, and by the open ends; the harbour station will have specially-constructed canopies to carry away the fumes from the engines when under the river, and these will rise up into ventilating towers some 40 feet above the street level. These towers will also ventilate the extreme ends of the station; while the main arch will rise, in one span of 90 feet, to a height of above

35 feet from the rail level. The York Street subway will be ventilated by cast-iron openings in the street, standing up to a height of about 8 feet. These will be ornamental, and used as safety islands for foot passengers on the street level. The increased mileage that will be used by each railway, measuring not from the point of junction with the present railways but from the end of the present station into the centre of the new central station will be—the Great Northern, about 500 yards; the Belfast and Northern Counties, about 1,720 yards; the Belfast and County Down, about 1,180 yards. About 1,233 yards of the line running to the junction with the Belfast and Northern Counties, and about 1,342 yards of that to the Belfast and County Down, will be covered over.

Mr. Lanyon went on to point out that the present passenger traffic into and out from Belfast is about 5,500,000 persons per annum, made up as follows:—The Great Northern Railway, about 1,500,000; the Belfast and Northern Counties Railway, about 1,500,000; the Belfast and County Down Railway, about 2,500,000; which figures, at the end of three years, will, at the same rate of increase as that of the past three years, stand at about 6,600,000. The changes proposed to be made will, in his opinion and in the opinion of those who are promoting the undertaking, very largely increase the passenger traffic on all the existing lines of railway, by means of the arrangements that will be made in local and main line traffic.

The lecturer then proceeded to describe the proposed new central station and hotel. The new station will have a superficial area of glass roofing of about 10½ acres, placed about 40 feet above the level of the platforms, so that the light and ventilation will be perfect. It will occupy the whole of Smithfield and the ground lying between Smithfield, Mill Street, and College Street, and from Queen Street in a westerly direction to a street to be made in lieu of King Street, some 50 feet west of it. There will be about 8,700 feet of arrival and departure platforms. Each arrival platform will have its own cab rank, with easy approaches to the surrounding streets. The station buildings

will be approached from Castle Street, which street will be made 60 feet wide, and all the other streets round the station buildings about 50 feet wide. The station buildings will be set back about 30 feet from the line of Castle Street, and will have a frontage to that street of about 530 feet, and a width of about 60 feet. There will be three approaches from the street level to the new station, one from a new street running from Castle Street to Berry Street, one in the centre of the station in Castle Street, and a third in King Street. From the station corridors, which are to be very wide, there will be staircases and lifts to each platform. There will be an auxilliary booking-office in Berry Street, quite close to Royal Avenue ; this will be mainly used in connection with County Down excursions and other traffic. At either end of the station their will be footbridges connecting all the platforms, and there will be exits from the station in Smithfield North, College Square East, and Queen Street. The site for the hotel has not yet been definitely fixed. It may be either Castle Street, over the station buildings, or at the corner of Royal Avenue and Berry Street. The accommodation in it will be from 150 to 200 bedrooms, and in addition to the usual hotel requirements there will be provision made for ample stockrooms and a hall for public and private meetings and entertainments. The hotel will also be fitted with passenger and luggage lifts and all modern conveniences. The station, the subways, the tunnel, and the hotel will be lighted throughout by electricity.

In conclusion, the lecturer said :—Assuming that the carrying out of the Central Station and railways scheme will be a great advantage to the city, and I believe it is almost a necessity, it deserves the cordial support of the citizens of Belfast; for, if the proposed junction of the three lines of railway is not effected now it will probably never be effected, because in the course of a few years, at the present rate of progress in Belfast, the site of the proposed station would be practically unpurchasable ; while if the matter is heartily taken up now there will be really no obstacle of any considerable dimensions in the way,

and in five years' time we may all hope to be here to see the trains of the three railway companies steaming into and out of the Belfast City Central Station, carrying passengers through from railway to railway ; carrying the city merchant in twenty or twenty-five minutes' time from the very heart of the city to his seaside home at Bangor, Helen's Bay, Whitehead, Whiteabbey, or Jordanstown ; or, in a shorter time, to Lisburn, Dunmurry, or Balmoral ; converting many of our neighbouring country towns into suburbs of Belfast ; and last, not least, delivering Her Majesty's mails and parcels direct into the General Post Office, and receiving them direct from the same establishment. These surely will be boons to the travelling and mercantile public of Belfast which, when realised, will excite wonder in their minds that the Belfast City Central Station and Railways were only so recent a creation.

Mr. YOUNG—Mr. President, as you have called upon me I may be allowed to say a word with regard to the geological features of the scheme. I have had some experience with foundations in Belfast, and I think Mr. Lanyon is not at all mistaken in what he says regarding that ugly word sleetch. It is a marine deposit, and it consists mainly of fine sand and clay of a tenacious character. It rests upon a bed of, not boulder clay as I think was generally understood, but a firm clay of a plastic character almost entirely free from boulders, so that I believe if the system of street piling that Mr. Lanyon referred to be carefully driven perfectly close, there need be no apprehension of the sinking of the buildings. With reference to the shield Mr. Lanyon must allow me slightly to correct him. In the case of the Thames tunnel there was a shield invented by Brunel, and I had the pleasure of conversing with one of his engineers when he described to me that very shield. It was not intended originally, but was designed subsequently when the bed of the river had broken into the tunnel. I think the position of the Central Station extremely good considering all the circumstances of the case. I was under the impression that Mr. Lanyon wanted to take the premises we are now occupying, but I don't

see them upon the map. I know he served the Trustees with notice. I quite agree with Mr. Jaffé that it would be most desirable to have this Central Station for Belfast, and the strange thing is that these railway gentlemen seem so apathetic about it. I cannot understand that. I am not much of a railway man myself, but I certainly think they should assist this proposal as far as possible.

Mr. MUNCE—I did not know I should be called on to speak, and am taken a little by surprise. It is rather disappointing that the diagrams are not clearer, as many at this part of the room were unable to see what was being pointed out. Probably every one in Belfast has the idea that a Central Station would be a great convenience, and the question has occupied the public mind for years. The old Central Company had various schemes for uniting our Railways, but unfortunately no scheme hitherto proposed has been successful. My remarks will only refer to the scheme as explained to-night. The position of the station would seem to make it impossible to pass from Great Victoria Street to York Street without a serious detour via either Donegall Place or the proposed new street off College Square North, instead of the direct route of King Street, Smithfield, and Gresham Street now available ; and it would have been interesting to hear the names of all the streets interfered with, closed, or left open for traffic, because connecting streets between different portions of the town are of much importance. It is a pity a complete longitudinal section of the scheme is not shewn to enable the audience to see clearly the levels with reference to the present surfaces of the streets, and how much of the railways are intended to be open and how much in tunnel—it would also have made the description of the ventilation more clearly understood. Mr. Lanyon mentioned one place where 1100 yards of line included 1300 yards of tunnel—this is not quite clear. We have not been told the intended gradients of the station approaches from the streets, which would be interesting, seeing that the platforms of the Central Station would be 4 feet below low water level, and those of the Harbour Station

between 30 and 40 feet below quay level. I could not follow the description of the subway along the quays, because high water level being about five feet below the quay level, openings at steamers would let in the tide. In constructing the tunnel under Rosemary Street with the shield, how will it be managed where the structure approaches the surface? Can it be made without disturbing the surface, and if not, how long will the street be closed for traffic? In the case of York Street the diagrams shew the railways, and a subway for pipes, but none for drainage. Subways are very good in their way, but it is found that 90 per cent. of the openings in streets are for service pipes and not for mains. There should be a subway on each side of the line. There are other matters on which information might have been given, but I will only mention the estimate. This is most interesting. We have read £600,000, but I am afraid there is an error here, as authentic records of similar works give the following rates:—Metropolitan Railway (London), £630,000 per mile; District Railway (London), cheapest parts £400,000 per mile; Severn Tunnel, £2,000,000 for 4⅓ miles, 2¼ miles being under the river, and taking fourteen years to make; Mersey Tunnel, £500,000 per mile. I trust Mr. Lanyon may get his railway made for the price named in the newspapers, but I fear it; perhaps he will give some information on this point. We are obliged by his interesting description, and hope he will not take these remarks as made in an unfriendly way.

Mr. Gray—As to the commercial aspect, I cannot speak, but I think none of us need be at all alarmed about the cost of the project; I am very sorry myself that I cannot join the syndicate. The general public, of course, will think not so much upon the commercial aspects of the undertaking, or upon the engineering skill displayed in it, as upon their comfort hereafter in travelling by it. Upon this point they may rest assured. When the matter is in the hands of gentlemen like Mr. Lanyon we may feel perfectly safe. As to the question of this unfortunate sleetch, I consider Mr. Lanyon has to a certain

extent placed himself at a disadvantage in making so much of the sleetch, because many engineering projects have been carried through in Belfast with water and difficulties that are far greater than sleetch ; I don't think he need lay much stress upon this. I would not go so far with Mr. Young as to depend upon the boulder clay alone ; I believe they will find not this clay so much as the solid substratum of red sandstone below it. Like one of the objectors who spoke, Mr. Munce, who tried to make minced meat of the whole affair, I should like to have seen a longitudinal section. I think you will find in the great majority of cases the tunnelling will be on a solid substratum of sandstone, and that there will be only occasional difficulties in the way. While this tunnel is quite feasible in the hands of competent engineers and supported by the people in London or elsewhere, it will be important to make it perfectly watertight.

Mr. Macassey.—It will be in the recollection of many here to-night, the statement made by a very eminent visitor we have had lately—I refer to Mr. Harry Furniss—that the Belfast people were fit for nothing but making money. I think if he came in to-night he would say that we could do more than make money. We can come and give a careful and reasonable consideration to a proposal, such as Mr. Lanyon has put before us, and measure its probabilities and difficulties, both from a commercial point of view and that of the prosperity of our city. I think, sir, it is a matter for congratulation that Mr. Lanyon has moved out of the usual course, because it is not a usual thing for the engineer of a scheme to put it before the public in a meeting like this, with the risk of hostile criticism. It is a matter of congratulation, further, that he has chosen your Society, presided over by you, sir, as the medium of communication with the intelligent public of Belfast. Now, you will all agree with me that the engineer has often to submit to criticism of a hostile and severe character. The unfortunate engineer has not only to submit his scheme to the public before it is properly matured, but is expected to answer questions before he has got his answers ready. Mr. Lanyon has taken

the proper steps to-night to put his scheme fairly before the public. As to the merits of the scheme itself, I think it almost goes without saying that it would be a good thing for our city, its suburbs, and its teeming population, if we had these three branch railways connected with a Central Station, and I think we should keep that leading fact before us when we come to consider and criticise. I think in answer to all the objections of my friend Mr. Munce as to whether this street is to be kept open or that one is to be closed, I should say, let us have our Railway, and let us have our Central Station, and the learned Town Clerk of Belfast, assisted by my friend Mr. Bretland, will take care of the streets. No Belfast man need be afraid of his interests so far as the stability of the streets is concerned. I consider the scheme as a whole on broad lines ; don't trouble us with matters of detail. There is no doubt if you make these railways, they not only do good to the town but increase its population. Numbers of our business men would be glad to have a Central Station. We could sleep in the country at night, and come to work in the morning. I think it would be a good thing if more of us did so, and I am sure this will be one result if the railways are made. As regards the details of construction, we know a little about the sleetch which has been so much spoken of. In the first work constructed by the Harbour Commissioners some years ago, the experience in connection with the dock walls was not a happy one. Sleetch was the difficulty, but the later engineering of the Harbour Commissioners under Mr. Salmond was very fortunate and very successful, and I should say in view of the building of a wall such as has been constructed by the Harbour Commissioners, knowing what I do of sleetch, that I do not anticipate any insuperable difficulty in carrying out the works. What Mr. Lanyon describes now has been done over and over again in other places. We are really following out the experience and practice of Glasgow, London, and other cities. Everything of this sort largely turns on the successful working out of details, but these have all been dealt with before, and I hope the public

in considering this scheme will not be led away from the main thing, let us have our Railway and our Central Station. I believe it would not only largely accommodate the present traffic, but would increase it. This tendency to run away into details is rather ill advised. It reminds me of a story regarding a shipwreck not long ago.—A farmer went down on the back of an old grey mare to the rescue. He backed the mare into the water where he saw a man struggling for his life. "Haud on by the tail," the farmer shouted. "Naw, naw," cried the other, "she might kick." "Toots, mon," replied the farmer, "what's a kick compared to droonin'?" The kick was a small thing compared with the man's life, and all these things are small compared with the great issue before you. The details will be thoroughly sifted and settled before the work is carried out. Mr. Lanyon has had great experience in such matters; and in going with a scheme of this kind before a Parliamentary Committee, it must be shown first of all that there is a great necessity for it. I do not ask you to attach any importance to my own opinions. I am here as one of the public myself, but I ask you on the evidence and the facts before you whether it is not a fair conclusion that the scheme will be a good one. I also refer you to the opinion of Sir Frederick Bramwell, a gentleman who has investigated matters of this kind. Our scheme is very much on the lines of those of London and Glasgow, and the difficulties suggested here have been overcome in those instances. The Glasgow folk are very shrewd, and if we follow their lines we shall not be far astray.

Mr. Conway Scott.—I am greatly disappointed, for I expected to have heard very serious and weighty objections raised to this line of Mr. Lanyon's, but the objections this evening are conspicuous by their absence. My friend Mr. Munce raised an objection that Mr. Lanyon did not produce certain sections which he considers necessary. He also objects because certain streets will be closed, but I think we may leave all these details to Mr. Munce himself and the Improvement Committee. The only objection that I have heard is the sleetch, and I really do

not consider that a very great objection. It is not such a difficult matter that engineers cannot overcome it. Why should Belfast stand in the way if these London people wish to spend a million of money in Belfast ? I have never yet heard of any English company proposing to spend £500,000 in Cork, Galway, or Dublin. They come to Belfast because they have faith and confidence in Belfast. I may give as an instance, that some gentlemen lately waited upon a distinguished Englishman in London on a certain business. The expressions of opinion that this distinguished Englishman made regarding Belfast appeared extraordinary to me. He said he considered Belfast was the most rising and prosperous town in the three kingdoms, and I quite agree with him. It is a compliment to you that an English syndicate should come over here and offer to spend their money and not ask you for a penny unless you like. Do gentlemen here think Belfast will remain stationary ? Englishmen don't. The Railway may not pay now, it may pay 20 or 30 years to come. There are many cities in England where there is more employment of a certain class, but I think there is no city in the three kingdoms where men, women, and children can get such useful and constant employment. I have heard that from workers themselves. There is another thing ; people are crowding into Belfast from every part of Ireland to educate their children and put them into business. The city, I think, is bound to go ahead, and if you don't support this scheme we have not as much confidence in our city as we ought to have. I think you will make a great mistake to reject this scheme. Regarding the difficulties, there are difficulties in everything ; but why should difficulties be considered so enormous in Belfast which have been overcome in London and other places ? I hope, gentlemen, you will support this Railway thoroughly and unanimously.

Prof. J. D. Everett.—The chief difficulty that I came here in the hope of hearing explained is a difficulty that was raised in a discussion which took place in this room upon the projected Channel Tunnel, and that is the enormous expense of keeping

out the water in addition to pumping it out in the first instance; but we have heard nothing of this to-night, and no one has told us that there would be any serious expense in pumping out the water coming in. It is a matter of detail which only practice can decide, but the difficulty would strike myself, and we know that Belfast is on a quicksand. I myself saw the screw piles driven by hand instead of by the usual mechanism, because the sand was so soft, when they were making the Central Railway Bridge, and we know that cellars in certain parts of Belfast are often flooded; but we have heard nothing to-night of the precautions that will be taken to keep out water. However, if the engineers are satisfied on that point, I am satisfied. I certainly think it is a great blot on our system generally at present, that when you want to go from Portrush to Dublin you have to make a break of a mile in Belfast. You arrive by one train and wait, perhaps for hours, until there is another train to start; it is a great nuisance. I don't think there should be any difficulty about the ventilation; the trains will be going the same way, so they will carry the air in one direction. I wish the project all success.

Prof. FitzGerald.—I think in his paper Mr. Lanyon very wisely avoided any discussion of estimates of cost, because in a general meeting such as this the majority of people present are not competent to form an accurate opinion of the value of estimates, so that in any case it is impossible to enter into a discussion on that point. However, I think we are all of the opinion that it would be a great convenience to have a station in some such central place as that selected. If circumstances, which invariably alter cases, had been other than they are, it might have been possible to put the station at such a level that streets would not have to be altered; but, of course, you have to do what can be done with the state of affairs as they are, and Mr. Lanyon has taken very great trouble in bringing this important subject before us in so interesting a manner. I shall now call upon him to make his reply.

Mr. Lanyon said in reply:—It has been more than gratifying

to me to find the sensible and kind way in which the remarks I have made to-night have been taken. No criticisms have been made that I could call unfair, or pushing a point against the scheme. My old friend, I think I may call him such for he knew me when a baby in arms, Mr. Young referred to Brunell's shield. Brunell invented a wooden shield which he wrapped around with iron and used most successfully; in fact it was the only thing by which they were able to face the difficulty of piercing the Thames Tunnel after it had been given up and closed for eight years. Regarding the remarks made by Mr. Munce, I don't think we need trouble ourselves further about them than to say we leave them with him at the Town Hall where he has all the plans, and any information that may be required from me in going through those plans I shall be only too pleased to give fully and in any way desired, except the estimates, and I ask him to forgive me about this, because I am so pressed that if I had to go into the details of the estimates I should collapse altogether; and I also quite agree with the latter speakers that the cost is a question for the gentlemen who find the money. (A voice, "Not altogether.") Some gentleman says "not altogether," but I think that the gentlemen who pay the piper should be left to choose the tune. The gentlemen I refer to ask the public for nothing. You as representing the public have the option, a complete option—there is no coercion whatever on the part of the London syndicate—of going on their line or not as you choose. You cannot expect to go for nothing. Is there any conveyance that you ever travel by, not excepting your own property or the property of another individual, that does not cost you something, be the same more or less? With regard to Mr. Gray's remarks, he is perfectly correct. We meet the red sandstone for a considerable portion of our work. I have simply given you the worst points in order to make you understand them. I have not told you the good points. Mr. Macassey has been good enough to refer to a high level line. We had a good deal to do with that together, and I must acknowledge his kind remarks of to-night as those

of a brother chip. From experience in connection with the Bangor extension of 1877 and '9, and the proposed extension of the Northern Counties to the old Academy buildings in Donegall Street, I have come to the conclusion that an overhead line is not feasible. The cost would be too great, and I think, if for one moment you follow me, it must be patent to everyone within my hearing that what I say is true. As to Prof. Everett's question regarding pumping, it will be almost unnecessary in this case, because the use of the shield and its accompanying air pressure would prevent water coming in, and also the street piling would prevent water coming in; therefore pumps are not likely to be much required. Of course if we come across streams they will have to be dealt with, either piped or pumped out; but as the gentlemen you have heard speaking, Mr. Young and Mr. Gray, both leading authorities on this question, have spoken about this clay or sleetch, I may tell you it is a perfectly fine clay, and so stiff that when the boring tools get into it they twist like a corkscrew. With regard to ventilation, of course in the down line there will never be any steam (in a down grade of 1 in 73 you won't require steam). (A voice, "But there will be smoke.") Of course there will be smoke in both, but the trains passing through will act as a piston, they will drive everything before them, and the fresh air will follow. I think these are the only remarks I have to reply to, and again thanking you for the kind way you have listened to me, I can only agree with you in wishing the scheme every success.

27th January, 1892.

Professor M. F. Fizgerald, B.A., C.E., in the Chair.

L. L. Macassey, Esq., C.E., Barrister-at-Law, gave a lecture on

THE FILTRATION WORKS FOR THE IMPROVEMENT OF THE WATER SUPPLY OF BELFAST.

The President said that before calling upon Mr. Macassey to read his paper he had to ask Mr. Murphy to move a resolution with reference to the late Bishop of Down and Connor and Dromore, who was a member of this Society.

Mr. J. J. Murphy said he had been requested to move, and he did so willingly, that the Secretary be directed to express the sympathy felt by the members of this Society with the family of the late Rev. Dr. Reeves, Lord Bishop of Down and Connor. To an Ulster audience, and especially to a Belfast audience, he need not mention how well known the late Lord Bishop was as an Irish antiquarian. Indeed, in some branches of that important subject he was the highest authority in the world. On coming to reside in Belfast about six years ago he immediately became a member of this Society, and although not a very constant attender at their meetings he took a warm interest both in the proceedings and the collection of the Society. He had no doubt the resolution would commend itself to the feelings of all present.

Mr. Lavens M. Ewart, J.P., seconded the resolution with feelings of the deepest regret. It was unnecessary for him to add to what Mr. Murphy had said upon the subject.

The motion was then passed in silence, and

Mr. Macassey then proceeded with his lecture, and said:—

The supply of water to such a city as Belfast must be regarded as a matter of supreme importance, and I, therefore, think it is a subject not unsuitable for consideration by a meeting of the members of the Natural History and Philosophical Society. Our programme for the past and current session has included several papers on subjects of great moment to the travelling public. We have had interesting lectures on channel tunnels, canals, and urban railways. But I now ask your indulgence for a short time, while I describe what is being done by our local water authority for the improvement of the quality of the water supplied to the residents of Belfast and the outlying districts. Such a matter has to do not only with convenience and comfort, but also with health and life, and it therefore seems to me a ground for congratulation that your Council has afforded me an opportunity of telling the members and the general public what has been done to make our water supply as good as possible. But, before going into the details of the case, let me say a word about the rapid growth of Belfast in population and also in trade and manufactures. In 1874, when I became connected with the water-works of the city, the population was about 185,000; now it is about 256,000, or an increase of about 71,000 persons. In other words, the Belfast of to-day is, roughly speaking, made up of the town of 1874, with the city of Cork added on. I should mention, however, that the public water supply is afforded also to residents in the suburban districts, with the result that the total population under supply is about 270,000 persons. In the same period—viz., from 1874 to the present date—the total daily supply has been gradually increased from 4,000,000 gallons to about 9,500,000 gallons. In 1874 the amount of water used for trade purposes was comparatively small, but at the present time, out of a gross consumption of about 35½ gallons per head per day, the special supplies absorb about eight gallons per head per day. Now, during the past fifteen years the members of the Water Trust have endeavoured to keep pace with the growth in the numbers of their constituents.

They have endeavoured to act as good trustees, and I think the general feeling amongst the public in Belfast is that the water supply has been fairly well maintained. Most public boards are usually regarded as targets for the attacks of both critical and dissatisfied people, but I think I may congratulate the members of the Water Trust on having suffered less from the arrows of the critics than most gentlemen occupying the same position before the public.

But, all the same, there have been some members of the community who have expressed doubts as to the quality of the water supplied to Belfast. Like all waters collected from a catchment of mixed character, that supplied to Belfast becomes more or less turbid after heavy rains. Thus when the reservoirs get rather low, towards the end of the summer, and a heavy rain occurs, the water becomes discoloured from the presence of suspended matter of an earthy or vegetable character. Now, the earthy element can be effectively got rid of by subsidence in a reservoir, but the operation is not so easily managed with vegetable matter. It is so light that it does not settle to the bottom of a reservoir. The Water Commissioners have very large storage space at their works. They have, in fact, some eight large reservoirs with a total storage capacity of about 2,200,000,000 gallons. And the beneficial effect of the subsiding power of such large reservoirs must, no doubt, be very great; but after all that care and attention can do in the matter, the town water has always a slight tinge of colour, slightly in excess of that supplied to Glasgow; and after heavy rains the amount of colour is very seriously increased. At various times during the past two years the quality of the town water has received close attention from the authorities. A number of reports and analyses have been made, and there seemed to be a concensus of scientific opinion that something should be done to give the town water to the consumers in as good a condition as possible. The Commissioners were satisfied that the water was good and wholesome, and so they were advised by high authority, but they determined to make it as good as possible. It was, therefore,

decided to follow the course adopted by other towns, such as Bradford, Liverpool, and Edinburgh, and to filter the town water. The necessary powers were obtained from Parliament, and the works are now under construction.

But before I proceed with a formal description of the filtration works, I must offer a few observations respecting the object of the process of filtration. Now, as is generally known, we do not get water absolutely pure in nature. Even in rain water there are found ammonia and particles of dust, earthy or organic as the case may be, which the rain, as it were, washes out of the atmosphere. Hence, where the expression pure water is employed, it must be understood in a limited sense—viz., water so free from objectionable constituents as to be safe and wholesome for potable purposes. Thus we find in many waters a considerable amount of total solid matters to the gallon, and yet the water may be quite suitable for drinking purposes. Within certain limits solid matters *per se* are not necessarily injurious, and the character of the solids must be looked to before an opinion can be formed. Thus, the presence of say ten grains of carbonate of lime per gallon in a drinking water would not condemn it, but two grains of organic matter to the gallon would show the sample to be quite unsuitable for all potable purposes. Impurity in water may exist in the form of mineral or organic bodies or gases, and the question is how these are to be removed, or so far reduced in amount, as to render the water desirable for domestic use. Take the case, then, of a water drawn from a river which drains a large tract of country like the River Lea at Cork or the Thames above London. In the latter case something like five millions of people draw their supply from the river. In fine weather the water is clear and well tasted, but in broken and rainy weather the rivers receive a large addition in the way of earthy matters, decayed vegetable bodies, and, what is the worst of all, a large amount of organic matter of an animal character. To a smaller extent the same applies to waters collected into reservoirs from catchments of a mixed character. In flood time the water

receives its burden of earthy impurities, and also those of a vegetable character—due to decaying leaves, weeds, grass, and perhaps a little bog stuff. Happily in the case of catchment area water there is not much danger from animal pollution, because the sources of such contamination are generally too few to have any material effect on the quality of the resultant water. Now, when the raw material, so to speak, is of such a kind, water authorities have in the past had rather rough times of it with their consumers, and, as the outcome of full investigation, sand filtration has been adopted in a large number of towns. There are, of course, other ways known of freeing water to a greater or less extent from the objectionable matters contained in it. I have already spoken of subsidence. There is also the aeration process, such as passing the water over a fall or weir. And, again, a new process has been tried by which an electric current is passed through the water, with the result that the organic matter in suspension is carried down as a precipitate. Most authorities, however, hold that filtration in some form or other is the only practicable mode of removing objectionable impurities from drinking water. And as my time is limited, I must not detain you by saying anything upon other methods of purification. To pass on, then, our first idea of filtration was derived from nature. Thus we have, no doubt, seen a well sunk near a river bank giving bright pleasant water, whilst that in the river was too foul to drink, or even to wade in. Again, one part of a river may be in a clay district, and the water muddy and unusable; but further down, with a slower velocity, and the water passing through gravel and sand, we get the water as clear as could be desired. After a good deal of failure, and a number of very costly experiments, the modern sand filter used by water authorities has resulted; and I think I may say with perfect accuracy, that when properly made and carefully worked it is a very efficient means of improving the quality of a town supply. The present system was not, however, settled all at once. We had lateral filtration, upward filtration, and finally downward filtration, and the latter system has taken the foremost place.

As will occur to those present, sand is not the only medium used for filtration purposes. This is quite true, and I regret that I cannot say something about the many filtering mediums now available for domestic use. Thus we have animal charcoal in grains and in block. We have also spongy iron and polarite; also the well-known and efficient *Filtre Rapide;* all of which for household purposes seem to leave nothing more to be desired. But all household filters require to be paid for, and to the general bulk of our population this is a strong bar to their use. Further, they require to be cleaned and renewed from time to time, and this is a further obstacle to their general employment. In fact, in many cases the domestic filter eventually becomes a valuable pantry ornament, and at this stage I must leave it.

By means of a well-constructed and well-managed system of sand filtration, the authorities in many towns have shown that it is possible to deliver to their consumers a water, bright, pleasant-tasted, and showing a fair analysis, which, if unfiltered, would be often turbid and unsatisfactory to the consumers. Take the case, for instance, of London, which mainly draws its supply from the Thames above Hampton Court. Here is a sample of unfiltered Thames water, taken in the month of July, which Professor Wanklyn shows, according to the well-known ammonia process, to contain as follows:—Free ammonia, 4·5 parts per 100 million; albuminoid ammonia, 28. After filtration through sand by one of the companies, the resultant water gave the following:—Free ammonia, 1 part per 100 million; albuminoid ammonia, 6. Before passing from this I may mention that on an average the Thames water after filtration gives an analysis as follows:—Free ammonia, 2 parts per 100 million; albuminoid, 8. But I shall now be asked what I mean by so many parts of ammonia, and in reply I say that many chemists accept this method of measuring and indicating the quantity of organic matter in a given sample of water. We all know the pungent odour often felt in the presence of decaying organic matter. This is due to the ammonia which results

from the destruction of such matter. Now, by the ammonia process the organic matter in a given quantity of the water is destroyed, and the resultant ammonia is measured. The ammonia is thus an index or measure of the organic matter present in the water. It may be asked, however, why we get the ammonia under the two headings of free and albuminoid. Well, the answer to this is very simple. Some of the organic matter may have already undergone decomposition, producing ammonia. This ready-made ammonia is called free ammonia. Then, there is some organic matter in the water which has not yet decomposed. Vegetable matter, for instance, takes more time to decompose than matter of animal origin. This the analyst destroys by distillation, and obtains the resultant ammonia, and the latter is called albuminoid ammonia. I must not, however, pursue this part of the case further. I merely wish to show that the organic matter in the water is in most cases the dangerous element, and the ammonia process professes to indicate how the water stands in this respect.

The Water Commissioners, after a full examination of nearly all the waterworks filters in the United Kingdom, determined to follow the same lines as London, Dublin, Bradford, Edinburgh, Liverpool, and a number of smaller towns. In these places the water authorities have adopted vertical filtration through a layer of sand, resting on layers of gravel and broken stones. The total thickness of the filtering materials varies from four to eight feet. As will be readily understood, the rate of filtration has a good deal to do with the success of the process. Thus, if we pass through a filter a given quantity of water in a day, it will be seen that the resultant water will not be so clear and good as if a period of two days was allowed for the operation. The speed of filtration is generally expressed as so many gallons per twenty-four hours per square yard of filter surface. In Edinburgh the rate is about 1,000 gallons per square yard of sand surface in the day. Throughout England the rate varies from 1,000 down to 500 gallons, and in the new works about to be described a speed of 500 gallons per square

yard has been adopted. This figure has been recommended to water authorities in England by the Local Government Board of Whitehall. The Commissioners have thus taken for Belfast the most efficient rate adopted in existing systems.

For dealing with that portion of the Belfast supply which comes from the Carrickfergus district, and which amounts to 7½ million gallons per day, five filter basins are being constructed at Oldpark near the present high service reservoir. One bed will be always out for cleansing, so that four will have to do all the work of filtration. The average effective area of each basin will be about 3,800 square yards, and the total of all the beds about 19,000 square yards. The water will be passed on to the filters from the Woodburn Conduit, and, after filtration, it will be delivered into the high-service reservoir. The Forked Bridge station will consist of four filter basins, one of which will always be out for cleansing. The quantity of water to be dealt with here will vary from three to four million gallons per day. Each bed will have an effective area of about 2,700 square yards. Thus at the two stations there will be in all some 30,000 square yards of sand area. The mode of construction of all the filters is the same. The basins are formed in cutting or filling, as the levels of the ground suit. The bottom and slopes are lined with 9in. thick of concrete, and a neat cope is formed above the ground line. The concrete was made of about five parts stone and chippings, then two parts sand, and one part cement of best quality. Along the centre of the floor there is a drain or channel for collecting and conveying the filtered water to the outlet. Now, let me describe the filtering material. This begins at the bottom with a layer of whinstone larger than road metal, gradually reducing in size to chippings, then to gravel. Afterwards comes a 2ft. 6in. layer of Dundrum sand, finishing fine on the top. The total thickness is about 5ft. 6in.; then there is 1ft. 6in. water space, and 2ft. of a margin. In total depth the filter basins measure 9ft. I now come to the subsidiary works, which require a few words of explanation. The unfiltered water is conveyed to a

spreading trough on the top of the sand, by means of which it is delivered gently, and disturbance of the sand prevented. There are pipes laid in the concrete slope from the bottom drains to allow the upward passage of the air as the water gradually works down from the top of the sand. Provision is made at the outlet wells, by means of a partition of stop planks, for regulating the quantity of water to be passed through the filter, or in other words keeping the proper head of water according to the condition of the filter. The upper edge of the partition is formed with a notch or check and a scale attached, so that the foreman can tell at a glance the rate per day at which the filter is working, and regulate the valve accordingly.

As will be recognised by those present, great care is necessary in washing all the coarse materials and sand put into the filters. This washing is done in tanks having perforated bottoms, and a supply of water laid on under pressure. Each tank holds about three tons of sand, and when the latter is laid in, the six-inch valve is opened. The water rushes up through the perforated bottom, and flows away at one end, which is made a little lower than the top of the tank. A few minutes of vigorous stirring up with shovels soon frees the sand from all earthy or vegetable matter, and it is then wheeled away to the filters. A permanent washing tank of the same kind is placed in the centre of each filter, and it is in these that the periodic sand-washing will be carried on from time to time. After being in work for a period varying from three to six weeks, a sand filter requires to be redressed. This operation consists in turning off the water, and then scraping the upper half-inch of sand in which the sediment from the water is generally found collected. The dirty sand is then passed through the washing tank, and afterwards respread on the top. With this the operation of cleansing or redressing is complete, and the filter is again ready for use.

But some one may, perhaps, now ask, does not a sand filter become foul all through its layers, after long-continued use? I answer no, provided the filter is regularly cleansed as I have

described, and that it is not overworked. By passing too much water through a filter the dirt may be driven down deep into the sand, and if this is continued long enough, the whole sand-layer may have to be taken out and rewashed. With proper working, however, experience has shown that all the visible dirt is caught in the upper half-inch of sand. The lower part of the sand-layer and the gravel and stones remain clean for years. In fact, I have known filters made over thirty years ago where the lower layers have never been disturbed.

Another question, however, arises at this stage, and it is this, "Why employ at great expense a depth of four to six feet of material, if the work is all done by the upper half-inch of sand ?" This is a natural question, but it is one that has never been satisfactorily answered. Many attempts have been made to filter with a thin body of material, but they have been failures. With the thin layers the water is not rendered so clear, and even when this has been done, the resultant water when analysed does not compare favourably with water filtered through the deeper stratum. What, then, is the nature of the effect produced by the lower layers of material upon the water passing down ? Observation by means of the ammonia process shows a greater reduction of the organic matter in the water than if a thin layer be employed, and yet there is no visible deposit on the lower sand and stones. Some authorities attribute this beneficial result to oxidation, but the answer to this appears to me to be that the air in the interstices of the sand and gravel has all been driven out by the water passing down. Again, the good work done by the lower strata of the filtering medium has been explained by other authorities in the following ingenious way :—In the water passed on to the filter there is a certain amount of free oxygen. This is not immediately operative in attacking the organic matter in the water ; but the presence of and contact with a third body—viz., the particles of sand or gravel—immediately renders operative the oxygen in the water, which then attacks the organic matter. This is known in chemical science as the catalytic process, and the

explanation is certainly very ingenious. I leave the matter, however, to be followed up by some one more competent than myself to deal with it, and I pass from this part of the case with the observation that the experience of some forty years shows that the thicker layer of filtering material has given very satisfactory results up to the present, and any saving to be effected by using a smaller amount of material will be accompanied by a loss of efficiency.

Let me now come to another question respecting the effects of filtration, and this is one of very great interest as well as importance. I refer to the biological influence or effect produced upon the filtered water by the process. Hitherto it has been supposed that filtration through sand or, indeed, any other material has not any effect in reducing the number of micro-organisms present in the water. I have often seen it stated that the pores of a sand filter are wide enough to allow thousands abreast per square inch to pass down. A very exhaustive series of experiments, made by Dr. Percy Frankland, would appear to show that filtration through sand, coke, or charcoal has, however, the effect of materially reducing the number of micro-organisms in the water under treatment. The original theory of filtration was that it cleared the water from visible particles, but that it had no further beneficial effect. Later investigations, however, showed that by the process the organic matter in the water was reduced to an important extent, and the inference was drawn that, therefore, the water was made safer for drinking purposes. The danger was regarded as existing in the organic matter, and medical men argued that the latter, when large in quantity, in its passage through the human system set up a state of intestinal disturbance which often resulted in zymotic diseases of some of the well-known forms. Thus, in the case of the Vartry water, when first introduced into Dublin, doctors were said to hold it responsible for a tendency to diarrhœa which prevailed for a long time in the metropolis. Now, it is very hard to say definitely whether organic matter in water is directly injurious

or not, but the experiments of Koch and Pasteur have established the fact that micro-organisms abound in waters highly charged with organic matter—in other words, the latter forms the nutriment for the micro-organisms. Hence, the less organic matter we have in a drinking water the fewer micro-organisms are likely to be present. The opinion is fast gaining ground that microbes have an active part in creating and spreading zymotic diseases, and this opens up a very wide field for discussion. Are all micro-organisms harmful to the human system, or only certain kinds of them? or are they only injurious in certain receptive states of the human subject, or perhaps in certain inflamed states of the microbes themselves after too free an indulgence in organic matter? These are questions of a highly interesting character, but we cannot stop to discuss them. Dr. Frankland has shown, however, by very numerous experiments, that in sand filtration the colonies of microbes are reduced to an extent ranging from 50 to 100 per cent., and that, within certain limits, the intercepting power is inversely as the speed of filtration. Why the upper surface of a layer of sand with pores large enough to be visible to the naked eye should intercept micro-organisms of which clusters of millions are invisible, is a question I cannot answer, and I leave it with the observation that the coating of sediment upon the top of the sand, which is more or less organic in character, forms a nutritive environment for the micro-organisms. Possibly the latter collect there rather than investigate the sterile regions lower down. It thus appears that with a well constructed sand filter, and regular redressing, water can be considerably improved in quality. The organic matter is reduced in quantity, and the micro-organisms to a very large extent intercepted.

The works which I have briefly described will cost, in all, about £70,000, and will be capable of filtering 11½ million gallons per day. The working expenses and annual cost of capital will come to about £3,650 per annum, or about £10 per day. This works out at 17s. 4d. as the cost of filtering one

million gallons of water, or one-fifth of a penny for 1,000 gallons of water, not certainly a very high rate. But now let me ask, is it worth while spending such a sum on the filtration of the city water supply ? Will the process do any substantial good ? First, then, let me point out that some of the gentlemen consulted in the matter have given their opinion that filtration would improve the appearance and quality of the water. Others again expressed their belief that filtration is necessary to render the water wholesome. In carrying out the system of works just described, the Commissioners have on their side all these chemical gentlemen whose attention has been called to the character of the water supply, But, again, the water will be clear and sparkling, and as such will be more attractive looking to the consumer than when tinged with colour. The public will, I think, in the future use more water both internally and externally, and this will, I think, be generally regarded as a most desirable state of things. Whether, however, the removal of a portion of the organic matter in the water, and the reduction in the number of micro-organisms, if any, in the water, will render the water safer, is a matter upon which I am unable to express a dogmatic opinion, though I must admit that nearly all scientific authority goes in favour of filtration. No one can draw the line and say when the quantity of organic matter in water becomes dangerous, but I think we can all admit that the freer the water is from organic impurities the more satisfactory it is in every way. Further, in time of epidemic the public will have all the more confidence in a public supply of water carefully filtered, and everything that gives real grounds of confidence at such times must be regarded as well worth having.

There is the further observation to be made in the present case, that the large outlay on the filtration works does not involve any increase in taxation. I think, therefore, the new works will be of great advantage to the public in Belfast. The water will be brighter and more wholesome ; its use will be largely increased both for domestic and special trade purposes.

The new scheme will prove beneficial both from a pecuniary and a sanitary aspect. For some time past there has been evinced on the part of our various authorities a desire to raise the health standard in Belfast. Large sums are being spent on sanitary improvements, and I consider that not the least important step in this direction will be found to be the determination of the Water Commissioners to carry out the large system of works which I have attempted to describe.

Professor Letts—I have listened with great interest to Mr. Macassey's paper, which deals with a subject not only of scientific, but also of practical and individual importance. Ever since I have been in Belfast, I have taken the greatest interest in the water supply, and it has been particularly pleasant for me to listen to Mr. Macassey this evening, for I look upon him now as a missionary might look upon a convert to his teaching. Some time (in fact, years) ago it might be remembered there was a newspaper controversy between myself on one side and Mr. Macassey on the other, on the subject of Belfast water; I contending that it would be much better for filtration, and Mr Macassey maintaining that it was already quite pure and good. I am glad to find Mr. Macassey has changed his opinion on that point. I still contend that the water at present supplied to the town is bad, perhaps worse than formerly; and with a bad water supply, bad drainage (as yet), and a filth-laden soil (as unfortunately was in the town), it is no wonder that the death-rate is high; and I have heard on sound authority that Belfast had the very dishonourable distinction of heading the list of the towns in the united kingdom in death-rate from typhoid fever. Our drinking water at present is derived from surface drainage, from the upland, charged with the excreta of animals—possibly of men also—and, no doubt, with artificial manures, and is supplied unfiltered. It is consequently foul and impure, a statement I can justify from experiments made in my own laboratory, and from the constantly repeated analyses of other chemists. In 1885 I analysed the water, and found that it contained no free ammonia, but ·15 per million parts of

albuminoid ammonia. I analysed again, and found that it contained free ammonia to the extent of ·02, while the albuminoid ammonia had increased to ·20. This, according to Wanklyn's standards, rendered the water entirely unfit for potable purposes. I think the Water Commissioners have incurred a very grave responsibility during the last ten years in not filtering the water, although they had the facts before them from the first, and not only the facts but the water also ! One look at the public swimming bath ought to have given them a lesson. And is it not possible that many avoidable deaths have occurred from their apathy in the matter? Filtration undoubtedly renders water purer and more wholesome. It has been demonstrated, in fact, that the filtration of sewage through six feet of a good porous soil rendered it as pure as Thames water. The sewage of Merthyr-Tydvil has been disposed of by filtration, and I think it is a pity that that of Belfast could not be dealt with in the same way instead of its being sent down the Lough to create a nuisance. With regard to the water supply of Belfast, the thing wanted is, in my opinion, not filtration, but a new supply. Rumours have reached me that there is a scheme under consideration to bring the water from the Mourne Mountains, and I hope it is true, for that water is pure and very soft, while the supply, I believe, is practically unlimited. In concluding my remarks, I congratulate Mr. Macassey on his paper and on his conversion ; I congratulate the Water Commissioners on their new undertaking ; and I congratulate the people of Belfast on the prospect of an improvement in the quality of their drinking water, which, without wishing to give any offence, I as a chemist must call almost of a dirty—nay, a filthy—character.

Mr. Wm. M'Cammond.—As a member of the Water Board, and a member of the Board when the scheme of Stonyford was brought before the town of Belfast, I took a very great part in it, and I am much pleased this evening with the report which has now been made by our worthy engineer, Mr. Macassey. Many years ago it was the intention of the Commissioners to

filter the water coming from above Carrickfergus, but at that time the site selected was found to be unsuitable. However, when the water was provided from Stonyford, the next step of the Commissioners was, if possible, to filter the water not only from Stonyford but from above Carrickfergus, and I am happy to say that one of these filters is now in actual operation at Stonyford, and the water is very much improved in appearance (of course, I am not a judge as to the quality of the water), and the second filter will very soon, I believe, be in operation. The Commissioners intend filtering all the water from the two districts. I am inclined to think that they will bring a scheme before the public within the next few months. I think also that that scheme, as far as I am concerned, will be the one that has been referred to by Dr. Letts, for the Mourne water. I believe that a large quantity of water, something above 20 million gallons per day, can be obtained from that district. However, if the Commissioners adopt this scheme they don't propose to take such a large quantity at present, but the quantity, I believe, will be suitable for the city for many years to come. Of course, we are most anxious to keep the water rate as low as possible, and a very important matter in connection with the scheme is the cost. However, from the figures, and the Board have gone very carefully into the figures, I believe if this scheme, which is now before the Commissioners, be carried out, that the increase in the rate will be almost nil. Last year the Commissioners reduced the "specials" in the city for water sold by meter, and charges on small ratepayers or small business people, such as those poor women who make their living by washing, and a number of our local carmen, and people of that class who are struggling to provide an existence for themselves. By the reductions I have referred to something about £2,000 last year came off the rates paid by a certain class of people. I think you will admit that the Commissioners have endeavoured not only to provide a pure and wholesome water, but to keep the rates as low as possible. I was very much surprised to hear the statement of Dr. Letts with reference to the quality of the water. I never

heard it get such a name before. There is one thing certain; the Commissioners will lose no time in the promotion of a new Bill for the future supply of as pure and wholesome a water as they possibly can get.

Mr. J. Brown—I have listened with interest to Mr. Macassey's very lucid description of the new filters, and I look forward with pleasure to having pure water to drink. I doubt if one would be correct in calling what we have at present truly water at all. Mr. Macassey, however tells us, on eminent authority, that it is very good water ; Dr. Letts says it is very bad ; while Mr. M'Cammond remarked that he was not a judge of water. Now, I drew attention some time ago in one of the local papers to the fact that in various English towns the authorities published periodical reports of the condition of the water supply, and pointed out that this should be done in Belfast also. The discrepancies and deficiencies in the opinions quoted above would then be accounted for, and we should all know what we were drinking. There seems no logical reason why it should not be done. The Commissioners do not, I suppose, want to conceal anything, and the citizens have certainly a right to know what they are paying for. Exeter is one of the towns publishing such reports, and I have here copies of some of these. The water is very much better than that of Belfast. It is filtered in quite the same way as ours will shortly be. With regard to the Mourne water, as I have already pointed out elsewhere, it is very pure when the weather is fine. Under other conditions it is very dark and peaty, and would require filtration.

Mr. J. H. Greenhill—From what Mr. Macassey has said, it will be some time before we can have the purely filtered water, and it strikes me as being very important that we should carry out domestic filtration to the fullest extent. A great many people employ filters, but I am afraid they allow them to become useless, even poisonous, from neglect. In the selection of a filter it is absolutely necessary that it should be easily cleansed, especially the filtering medium, and the oxidising material should be renewable.

Mr. ADAM SPEERS.—I am sure all present have been much interested in the instructive and eloquent lecture we have just heard. Mr. Macassey, in his own clear and happy manner, has given us much information on what is to the citizens of Belfast a most important subject. In the lecture, I noticed that reference was made to a series of experiments made by Dr. Percy Frankland some years ago with a view to determine the efficiency of sand filters in removing organic matter and microbes from drinking water, when it was discovered that sand filters were efficient beyond previous expectation. I remember reading of these experiments in some of the scientific journals of the time, and, if I don't mistake, it was stated that the sand used which produced the most unexpected results was not of the ordinary sort, but a green ferruginous sand. It occurred to me while Mr. Macassey was describing the mode of construction of the filter beds, whether it would not be possible to get some of this ferruginous sand and use it as part of the filtering medium. We were not told what kind of sand was to be used, whether Lough Neagh sand or pure sea sand. (Mr. Macassey, "Both kinds.") I think we may be all perfectly satisfied that the filtration works are in safe and skilful hands, and that not only the quality of the drinking water, but also the health of this great community will be greatly improved after the completion of the works.

Mr. WM. GRAY.—I am very deeply interested in this question, but have been utterly nonplussed by the statement of one of the gentlemen behind me who gives such a bad character of the water of Belfast. There is some consolation in the fact, that there is great diversity of opinion among the chemists themselves, as exemplified this evening. The Commissioners have done wonders, under the superior direction of our good friend Mr. Macassey, in coping with immense difficulties. Regarding the materials Mr. Macassey intends to use;—in nature, fine clay or earth does more in the filtration of the water than sand; it has the properties necessary for transforming even sewage water into pure water. At the same time, I agree with the remedy that Mr. Macassey has suggested. This point, however, suggests

itself to me, that when you have all these tanks ready and leave them for a month or so, will there not be on the surface an accumulation of animal and other matter of a more or less injurious character? A serious difficulty and expense is that of getting rid of the impurities that are left in the filter by the process of filtration. I entirely agree with the suggestion of Mr. Greenhill, that we should filter our water at home, and keep our filters thoroughly clean. We should at the point of consumption have full control of the filtering process.

Mr. Richard Patterson—I have visited the filter beds which have been so lucidly described by Mr. Macassey, and I should urge my fellow citizens at the earliest opportunity to see these works for themselves; it will shew that the Commissioners are doing a most excellent work, and all ratepayers will be satisfied that they are getting good value for the rates they are paying. The £70,000 I consider a mere trifle as compared with the vast amount of good that will result from the works which have been projected and are now in course of construction. I listened with surprise and almost horror to the remarks of Professor Letts, who I am sorry to see has gone out of the room. I believe if he had made his remarks at the temperance meeting which is being held in the Exhibition Hall to-night there would not have been a teetotaler left in all Belfast. I have no hesitation in saying that for years we have been getting a liberal supply of very good water, and I think that the death rate which Professor Letts dwelt upon as being so high may be attributed to other causes rather than to impure water.

Mr. J. H. H. Swiney—As to the matter of the cost of these filters, which Mr. Macassey has said will be £70,000, I worked that out at so much per square yard; and it may be of interest to tell yon that filters recently constructed at Warsaw and St. Petersburg cost respectively £8 8s. od. per square yard and £3 7s. od. per square yard, while here in Belfast the cost is only £2 13s. 8d. per square yard. As to the necessity for the filtration of the water here the only fault I have to find is that it was not begun sooner. I suppose it is from 20 to 25 years since the

Commissioners went first to the Woodburn district. The gathering ground was at that time a howling wilderness. Now those commons are cultivated, and there is certainly every reason for filtering the water caught off them. In looking out for any more extended supply for Belfast what I would say is, get away from the city and from any possible source of pollution or contamination, because one of the first conditions of filtering is good raw material.

Professor J. D. Everett—I had occasion a few years ago to express my views upon this subject, having been asked to preside at a lecture on filters in the Workingmen's Institute. I then expressed the opinion that the Water Commissioners should filter the water before supplying it to the town, and that this would be much less trouble than for every consumer to clean the mud out of his cistern and use his own filter. I am of the same opinion still. I have tried from time to time to obtain the best possible filter for my own use. The one which I have been using for some time is Maignen's, which provides every facility for renewing the cleansing màterial. One point strikes me as strange in Mr. Macassey's diagram—the filter appears to be standing on its head. The common sense course in cleaning out anything would appear to be to clean out the coarse particles first and the fine ones last. Here, however, we have fine sand at the top, then gravel, then stones. I suppose, however, the object of the gravel and stone is merely to support the sand. I conceive that this project will be of very great value to the town, and I must congratulate Mr. Macassey on putting it so clearly before us.

Mr. E. N. MacIlwaine—I must join with the gentlemen who have already spoken in thanking Mr. Macassey very much to-night, and in congratulating ourselves on the hope that we shall very shortly have very pure water to drink. Perhaps I have had more experience than most people here in drinking impure water ; and as an illustration of the benefit of using sand as a filter I may mention, when living in Queensland, at times the only water available was very impure, and the means

we adopted to render the water drinkable was digging a hole in the sand close to the water and allowing it to filter through the sand. By doing so we got fairly pure water, at all events not dangerously poisonous, or I should not have been here to-night.

Dr. J. M. MacCormac—We all know water is liable to be contaminated during both storage and distribution. And as regards filters, no matter how perfect in their construction, no person can with certainty say how long a filter will remain absolutely efficient. Would it not, therefore, be well for a chemical analysis and also a microscopical examination of the water supplied to our city to be made at short intervals by a competent person, and the result of these examinations to be published by the city press? The public would thereby gain most valuable information, and the medical faculty would be placed in possession of facts of the utmost importance. I would further mention that the principal diseases resulting from drinking unwholesome water are typhoid fever, cholera, dyspepsia, catarrh of the lungs, ulceration of the throat, scarlet fever, and a disease of the bones, besides certain skin diseases. All this shows the great necessity of having drinking water perfectly pure, and free from not only animal matter but also chemical impurities. As regards filters, I consider the Carbon Filter the most useful when the water can be allowed to filter slowly, and is consumed immediately or soon after filtration; and that the Spongy Iron Filter retains its efficiency for a long time; where it is necessary to filter rapidly and to keep the filtered water some time before consumption, this filter is preferable.

Professor FitzGerald.—As to the question of Mr. Speers regarding the nature of the sand, in Dublin some experiments were carried out by Dr. Adney as to the filtering effect of pumicestone, quite loose, like cinders, over which sewage was run, and, purely by aëration, completely purified. At Antwerp the water has been for some years purified by being put through drums containing small pieces of iron, which are rolled over and over. This produces a sort of extremely muddy water, which, on filtering through an ordinary sand filter, is completely

purified. Bacteriological experiments show conclusively a very marked effect of iron in freeing the water from micro-organisms, whether by actual destruction of the microbes, or by causing them to be entrapped in the muddy precipitate and filtered out along with it.

Mr. MACASSEY said in reply—I must trouble you again for a few minutes. I am sorry my friend Dr. Letts has left the room. I should have liked him to be here while I make a few observations in reply to his statement. There is no doubt that a few years ago there was a controversy in the newspapers—some of you may remember it—in which the principal writers were the learned professor and myself. You can quite understand the difficult position in which I was placed. I was purely an engineer, and knew nothing about chemistry. However, I adopted a safe course, I advanced nothing, but I dealt with the matter as the German critics deal with our venerable old Bible, I went on external evidence, and the professor was the first person to drop the controversy. It is no doubt surprising to hear the difference of opinion among chemists as to the water in general. Some describe the water as most excellent for all purposes, while others tell us it is impure and dangerous. I think you will come to the conclusion that the Belfast water is really not so bad as it is stated to be, but we had better spend a little money and make the thing all right. An eminent chemist, Professor Tidy, of London, after a complete and careful examination, told the Commissioners that the water as furnished by them was a wholesome water, and would not be likely to produce disease. Mr. Greenhill has mentioned domestic filters. I had intended dealing with these but found that the subject would make a very good paper in itself. At some future time I shall be much pleased to bring this subject before the Society. With regard to the sand to be used for the purposes of filtration in connection with these works, we use both sea and Lough Neagh sand. Will that sand be effective? In my opinion it will. In the early experiments to test the efficiency of sand Professor Frankland did use the ferruginous sand, but in the latter experiments as

explained before the Institution of Civil Engineers in London he used the sand now employed by the London Companies. With regard to the Mourne water, you must excuse me if I do not say anything, as this matter is now *sub judice.* The Commissioners have collected a large amount of information with regard to it, and you may rest assured when they do come to a conclusion on this important matter it will be a wise one and in keeping with the views of the majority of their constituents.

2nd February, 1892.

PROFESSOR M. F. FITZGERALD, B.A., C.E., in the Chair.

SEATON F. MILLIGAN, Esq., M.R.I.A., F.R.S.A.I., gave a lecture on

THE EARLY CHRISTIAN ARCHITECTURE OF IRELAND.

THE CHAIRMAN, in introducing the lecturer, announced that that there were on exhibition that night two uniforms formerly worn by Henry Joy M'Cracken, who was executed in Belfast in 1798.

The LECTURER said :—Before proceeding with my paper, I wish to make a few introductory remarks, and will ask the first photograph to be shown upon the screen. The group of persons here presented to you are members of the Royal Society of Antiquaries, Ireland, photographed on the occasion of their summer meeting, held in August last. The place, Dunlo Castle, County Kerry, once the stronghold of O'Sullivan Mor, was erected in A.D. 1215, and dismantled in 1641 by Ludlow, one of Cromwell's officers. Dr. George Stoker has repaired a portion of the castle, in which he now resides, and he and Mrs. Stoker kindly invited the Society to luncheon, and also to inspect an unique Ogham cave situated close by their residence. The members were photographed after luncheon. The picture I now present was taken by Mr. William Gray, a vice-president of the society, to whom I am indebted for this as well as several others, which I shall show you.

The summer meeting of 1891 was held at Killarney, on which occasion Lord James Butler, president, took the chair. The Cambrian Archæological Society joined us by invitation at

Killarney, and accompanied us during the entire tour. Several eminent men were of the party, including Professor Sayce, of Oxford ; Professor Rhys, of Cambridge, president of the Cambrians ; Professor Stokes, D.D., of T.C.D. ; and others. A series of excursions, extending over ten days, was arranged to visit the ancient churches, oratories, and bee-hive huts near Dingle, as well as the ancient monasteries and churches in the Counties of Limerick, Clare, and Tipperary. The views of these ancient monuments of early Christian art were taken by various members of the society during these excursions, and I only regret that it has not fallen to abler hands to present them to you.

This is probably the only public occasion I may have to announce that the next summer meeting will be held in Belfast in the month of August next, and it is proposed to have a series of excursions extending through County Down, particularly in the vicinity of Downpatrick. Should any ladies or gentlemen wish to join the society now in anticipation of this visit, if they forward to me their names and address I will attend to it. It is now a great many years since the society last visited Belfast, and it is probable that we shall have a large number attending, and that the meeting will be a great success.

The early Christian architecture of Ireland is a subject which should specially interest Irish people, as it leads us back to a remote period in our history, when the Irish had just emerged from Paganism, and embraced the Christian faith with all the warmth and fervour of their Celtic nature. Stimulated by a holy zeal for the new religion, the clergy and people exerted themselves to the utmost to erect temples, humble though they were at first, in which to celebrate Divine worship. These primitive churches became associated with the names of their founders, which have left a clue to the dates of their erection. The first churches were of a very humble kind, constructed of timber and roofed or thatched with reeds or straw. We need not be surprised at this, as in our time in new countries like the Western States of America, on the frontiers, log

churches were quite common, being the only kind it was possible to have, until the country became more densely populated. Our ancient records frequently refer to the "Duirtheachs," which were small churches or oratories constructed of timber; the name literally means oak house. These churches of the earliest period were frequently erected within a fort, such as a cashel or rath, which the principal man of the district, if a Christian, would place at the disposal of the Christian priest. No vestige, of course, remains of such structures. The Venerable Bede, in his works, referring to the early Churches, states that St. Finian, who had been a monk of the Monastery of Iona, on becoming Bishop of Lindisfarne built a church for his episcopal see, not of stone, but altogether of sawn wood, covered with reeds, after the Scotic (or, as we would now say, the Scottish), that is the Irish manner. In Tireachan's annotations on the life of St. Patrick, preserved in the Book of Armagh, a seventh-century manuscript which was in the hands of the late Bishop Reeves at the time of his lamented death, it says—"When Patrick went up to the place which is called Fiorrgea of the sons of Awley, to divide it among the sons of Awley, he built there a quadrangular church of moist earth, because wood was not near at hand." Here we observe in Saint Patrick's time what we would now designate a mud house was erected for a church. I may mention that the district here referred to, the barony of Tyrawley, is still as bare of wood as at the time of Saint Patrick. In the life of Saint Monena, compiled in the twelfth century, as quoted by Ussher, it is recorded that she founded a monastery which was made of smooth timber, according to the fashion of Scotic nations, who were not accustomed to erect stone walls. We may conclude that Duirtheachs, or timber churches, were numerours in the early days of Christianity, especially where timber was plentiful.

That stone churches were equally numerous seems evident from the frequent mention of the Daimhliags in our ancient records, as well as from the great numbers still standing, particularly in the South and West of Ireland. The stone buildings

known to the Irish in the Pagan period were the Cashels or Cyclopean forts, built of stone without mortar, the only entrance to which was by a square headed doorway, with jambs inclining inwards towards the top. Within these circular forts may be observed, even in the present day, the primitive hut or dwelling made of stone in the shape of a beehive, examples of which we now place before you. One of the most ancient stone churches in Europe is Gallerus, situate about seven miles from Dingle, County Kerry, near the shores of the Atlantic. The external dimensions of this little church are as follows :—Twenty-three feet long, eighteen broad, and sixteen high to the apex of the roof. The door is square-headed, and measures five feet seven inches high, two feet four wide at the base, and one foot nine inches at the top. The wall at the base is four feet thick, and gradually lessens to the top. It is lighted by a single window of very small size in the east gable ; and here we may note that all our ancient churches, with very rare exceptions, have the door placed in the west gable, and a window opposite in the east.

Dr. Petrie quotes from one of our ancient manuscripts—a tract on the Brehon Laws, now in the library of Trinity College, Dublin—as well as from the Book of Ballymote, in reference to the construction of the ancient churches. The tract refers to building both with stone and timber, and the payment according to the dimensions and class of the building, all the particulars of which are minutely stated. The payment was made, not in coin, but in cattle, which at that period was the usual medium of exchange. The tract gives the dimensions of the Duirtheach, as well as the Daimhliag, and the number of cattle that were to be paid for constructing it according to the measurement. The ollamh saer, or chief builder, was required to be equally skilled in the art of building with either stone or timber. The usual size of an oratory, internal measurement, was fifteen feet long and ten feet broad, with one door in the west and one window in the east. This coincides with the inside dimensions of the oratory of Gallerus. In the next style of oratory, which is an advance towards the present shape, the walls were built perpen-

dicular about six feet or more, without mortar, and the stone roof sprang from the side wall by each succeeding stone overlapping the one beneath, till one stone keyed it at the apex. The small church of Killelton, about two miles from Dingle, is of this class. The dimensions of this little church are sixteen feet long and ten feet six inches broad, inside ; the walls are three feet six inches thick, and the door is two feet wide at the base, one foot nine inches at the top, and five feet six inches high. The next step attained in the art of building was to pour liquid clay or gravel through the interstices, which made the wall more air-tight. The example of this class of ancient masonry may be seen near the village of Raholp, a few miles from Downpatrick. The little church of Raholp is built within a rath or fort, as its name implies. These churches were built of unhewn stones ; sometimes the jambs of doors and windows were dressed. The doorway was invariably square-headed, with one, or sometimes two, stone lintels, and the jambs inclined inward from the base. This style of church prevailed in Ireland for more than five centuries, up to the introduction of the Romanesque style, about A.D. 1002. If we try to find examples of such primitive churches elsewhere in Europe, with a few isolated exceptions they are only found in Greece, where the most ancient churches are similar in style to those in Ireland.

If this style should be traced further back, we find its original home was Egypt. There it was derived from the rock-hewn temples of that country. Our ancient Church ritual was derived from the Eastern, not the Western Church. The Irish Church celebrated the great festival of Easter after the manner of the Greek or Eastern Church. This gave rise to many bitter quarrels, particularly in the North of England, between the Irish monks of Lindisfarne and the followers of Saint Augustine, as well as in Ireland after the Anglo-Norman invasion, between the native Irish clergy and those of the Anglo-Normans who were members of the Latin Church. I refer to this to show that our early Christian architecture was more influenced from the East than from the West.

The Christian architecture of Europe had its origin in the temple architecture of Rome in Pagan times. The original type of the Christian temple was the Roman Basilica. Mr. Fergusson says in the time of Augustus Roman architecture was of the Grecian style, without arches or vaults, but, by the gradual process of evolution, in the age of Constantine it had become changed to suit the requirements of Christian worship and ceremonials. Romanesque architecture was based on that of the period of Constantine, and prevailed over the entire Roman Empire, both east and west. The Byzantine was derived from it in the east, and the Gothic in the west. In Ireland the ancient entablature or Egyptian style of architecture survived till the early part of the eleventh century. The Romanesque was derived from the Continent—most probably from France—and came direct to Ireland, and was in no way influenced by England prior to its introduction here. If we attempt to solve the question that arises, how did Egyptian architecture reach Ireland, we will find that not alone the architecture, but the personal ornaments of the people of both countries were similar. A short time ago an article appeared in the journal of the Royal Society of Antiquaries giving illustrations of fancy glass beads from Egypt, and comparing them with those found in Ireland, showing they were both of a similar class—in fact identical. Metallic ornaments are similar in shape and design in both countries, and at the present moment I have specimens of bracelets and other ornaments brought from Central Africa, of the same shape and design as the ancient Irish ones exhibited in our museums. Independently of a remote connection in Pagan times, there was an intercourse in the early part of the sixth century, and probably during the latter part of the fifth, with the Christian monks of Egypt. It is from that period we date churches such as Gallerus and Killelton. The former is pyramidal in shape, such as we should expect from a people conversant with the land of the pyramids. In the third century monasticism originated in Egypt, and spread from it to Italy, and thence to the islands of the Mediterranean; thence to

Spain and Gaul ; and ultimately reached Ireland about the sixth century. The Egyptian monks were anchorites and coenobites, who isolated and secluded themselves from the world as individuals and as communities. They had a strong partiality for living in islands ; they first settled in the islands around our western coasts, and afterwards in the islands of the larger lakes. The following were occupied by these monks :—The greater Skellig, the Arran Islands and others off the Galway coast, Innishmurray, Tory, Rathlin, and the Copelands ; Devenish in Lough Erne, Inniscaltra in Lough Derg, and some of the islands in Lough Ree. One of these anchorites had his dwelling on the top of Slieve Liag, in Donegal. St. Anthony was the founder of these monastic orders in Egypt. He lived to the age of ninety, and before his death had 5,000 followers.

The lecturer gave further details of the origin of monasticism, and proceeded to say:—These ancient monks lived in a different manner from their successors in the Middle Ages. Their dwellings were like those of the people of the district in which they lived. If they knew the art of building with mortar, they did not introduce it here at first, but were satisfied with such dwellings as were then common in the country. We have examples of these stone dwellings, and the remains of their ancient churches on the Skellig Rocks, as well as on the coasts of Kerry, Galway, and Clare. They have stood there since the sixth century in the most exposed position in Europe, on an isolated rock some 700 feet above the sea, exposed to all the storms of the Atlantic. The late Earl of Dunraven was the first to describe and get photographed these remains, dedicated to St. Michael. The Admiralty placed at the disposal of the Antiquarian Society a gunboat to bring the members from Dingle to the Skelligs, a distance of forty miles. As the voyager is exposed to the full fury of the Atlantic rollers, and as it is not always practicable to land, all the members did not accept the offer, but an alternative trip to Ardfert and Ratass, near Tralee, was arranged for them. Mr. Milligan proceeded minutely to describe the Christian remains on the Skellig Rocks, and

showed a series of photographs that give a very realistic picture of them. They consist of a number of stone beehive huts, and the remains of St. Michael's Church, dating probably from the sixth century. There are also crosses, burial monuments, and oratories. On the sea side is a huge Cyclopean wall, built plumb with the precipice. Mr. Milligan proceeded to describe and show photographs of the ancient churches with square-headed doorways. A photograph was shown of the doorway and east window of the church of Ratass, near Tralee, built in the Cyclopean style, and he referred to other churches of that early style, notably to the doorway of Maghera Church, County Derry ; also the church of Banagher, near Dungiven, in the same county. The earliest churches are small in size, oblong in shape, and devoid of all ornamentation. They consist of one apartment only. Where there is a chancel, it can be shown to have been added to it at a later period. Though the earliest churches of the entablature style were devoid of ornamentation, Dr. Petrie believes this did not arise from poverty or ignorance of the arts. He says if we examine the metallic work of this ancient age, particularly the croziers and the shrines for the bells, we shall see that artistic intelligence of a high order existed. The illuminated manuscripts from the seventh to the tenth century are also evidence of artistic taste of the highest order. The Irish were naturally conservative, and they clung to old forms and customs. The first churches erected by St. Patrick were of this type, and they adhered to them long after they were able to do better work. There was a style of stone roofing invented in Ireland and peculiar to it, which ultimately reached great perfection in the twelfth century, as exemplified in Cormac's Chapel. The oratory of Gallerus would seem to have been the original type of stone-roofed church, from which, by a gradual advance, our native workmen ultimately succeeded in the twelfth century in producing Cormac's Chapel and the Church of Queen Deirvorgilla at Clonmacnois. For a period of about 700 years native art flourished, until it became suddenly extinguished by the unsettled state of the country consequent on the

Anglo-Norman invasion. From an architectural point of view our primitive monasteries were not much ; from an educational point they were amongst the first schools in Europe, where the youth of not only England and Scotland, but the Continent, came to be educated. Our ancient ecclesiastical system did not require the large churches of England or the Continent, as it differed from that of those countries. The churches were usually small, but we occasionally find a number of these small churches grouped together, usually seven, as at Glendalough, Inniscaltra, and other places. Romanesque architecture was first introduced into England by Edward the Confessor, when rebuilding Westminster Abbey in the year 1066. Fifty-eight years previous to that the little church of St. Caimin was built, or rather probably rebuilt, by Brian Boru. It was the first church in Ireland built in the Romanesque style. This style was highly ornamented, and had circular arches. In the earliest Romanesque the stone lintel was retained, over which was superimposed the Romanesque arch. Irish Romanesque was influenced in some of its features by the old entablature ; the recessed pillars of the doorways inclined inward ; they did not stand out boldly from the jambs. The chevron, zigzag lozenge and bead ornamentation usually decorated the mouldings, together with that beautiful interlacing work for which Ireland was famous. Examples of Romanesque were shown—the little church of Aghadoe, near Killarney ; Kilmelkedar, near Dingle ; the church on the island of Innisfallen, Kilkeen, County Limerick ; and Cormac's Chapel, Rock of Cashel. The doorway of Clonfert Cathedral was shown. It is a beautiful example of the Hiberno-Romanesque ;—the date of its rebuilding was 1166. Tuam Cathedral, another example of Romanesque, was built in 1085. It was in the twelfth century that the cross of Cong, the shrine of Saint Manchan, the shrine of the bell of Armagh, and many other of our exquisite works in metal, were made. A few words at this point about the architecture of the round towers. They seem to show various stages of development, both in architecture and in masonry. The earliest belong

to the period of square-headed doorways with inclined sides, and the latest to the Romanesque or circular-headed doorways. The style of the doorways and windows of the round towers, as well as the masonry, compared with precisely the same class of work and design in the churches, the dates of which are known, is, to my mind, one of the most convincing proofs of the Christian origin of the round towers. In Glendalough and Clonmacnois a round tower is in each place built into the church, forming part and parcel of it ;—this also is a very strong testimony on the side of those who believe in the Christian origin of the towers. Miss Stokes refers to an important discovery made in the year 1847 at the base of the round tower of Kilkenny, where it was satisfactorily shown that the tower was built on a portion of ground that had been used for centuries previously as a Christian burial-ground, and from the position of the bodies under the base of the tower and of portions of the coffins, it was satisfactorily established that Christian burial had taken place there long previous to the building of the tower. Pointed, or Gothic architecture, which superseded the Romanesque, was introduced in the North of France towards the close of the twelfth century, and rapidly spread to England; the choir of Canterbury Cathedral was built in this style from 1174 to 1185. The Christian architects of the twelfth century constructed clustered columns, groined vaults, pointed arches, and flying buttresses, which enabled them to dispense with the massive walls of the Norman builders. The introduction of high pointed arches, in which the weight of the superincumbent wall rested upon a point, the crown of the arch, and thus diminished the powerful outward thrust of the round, heavily-loaded arch to the utmost possible extent, gave quite a new character to the architecture of the time. The walls were now light and lofty, and the supporting piers were made correspondingly light. The result was the Gothic cathedral, with its spacious nave and choir, its airy spire, and infinite variety of graceful and fanciful decorations. Examples of the transition from the Romanesque to early English pointed architecture were

shown, as well as a large number of monasteries and cathedrals of the early English pointed style. Amongst these were the monasteries of Kilmallock, Quin, Adare, and Askeaton; the abbeys of Holycross and Greyabbey; the cathedral of Ardfert and the monastery of the same; and the cathedral on the Rock of Cashel.

A fact worth noting is that the sites of our ancient churches seem to have been previously associated with Pagan ceremonies and observances. Many instances of this have come under my own notice. Holy wells, and bullaun or cup-marked stones, are usually found in the vicinity of the most ancient churches. Patterns are held on a particular day each year, said to be in honour of the founder of the church. It is not generally known that in almost the centre of the roadway near Saint Columb's holy well, in the city of Derry, there is one of these ancient Pagan bullaun stones, with two basin cavities in it. The holy well is close by, and has been covered in, and a pump placed on it. It is convenient to the site of the ancient monastery of Saint Columba. Close to the ruins of the ancient church of Killinagh, near Blacklion, County Cavan, there is a holy well, and a peculiar cup-marked stone with nine basin cavities in it. Saint Lowry's holy well supplies a large portion of the town of Maghera with water to the present time. At Clonmacnois, between the cathedral and the Church of Queen Dervorgilla, are several bullaun stones. The water lying in the cavities of each is supposed to cure certain specific diseases. In the County Kilkenny, three miles from Graigue, is the small Church of Ullard, with an ancient cross. Beside it is a holy well, and several stones with basin cavities in them. On a certain day each year a pattern is held in honour of the founder of the church. The explanation is that the foundation of these churches goes back to a most remote period, when the people were just emerging from Paganism. The early saints, instead of rudely breaking them away from the holy wells, baptised them there, and the Pagan ceremonies were changed into a commemoration of the name of the holy man who was the founder of the church.

Mr. Young.—Mr. President, ladies and gentlemen, at this late hour it would be almost an impertinence on my part to offer anything like a criticism on the very interesting lecture Mr. Milligan has delivered. He has gone over a very wide range, and given a complete historical account of the development of architecture in Ireland. I can quite conceive the immense trouble Mr. Milligan has had both in writing his paper and in procuring these photos, and although I believe our rule would prevent us moving a formal vote of thanks, I think it is one of the occasions when a rule might be broken, and I consider that the very best thanks of this meeting should be given to Mr. Milligan, and along with this I have pleasure in coupling the services of our friend Mr. Robert Welch, who has been very kind in using his lantern; our best thanks are due to both these gentlemen.

The Very Rev. J. O'Laverty.—I really do not know whether to praise more the lecture or the beautiful views. The lecture, though very interesting, would have been unintelligible to a great many of the audience without the beautiful views, and the views would have been unintelligible without the extremely lucid lecture which accompanied them. These views exhibit the earliest form of architecture in Ireland, and it is very singular that we have no such things to exhibit in the North of Ireland. It is only in the South and West that these ruins have been preserved. The few things that were exhibited belonging to the North of Ireland are in themselves very beautiful, but, unfortunately, in this portion of Ireland we have a propensity to destroy everything. The round tower of Downpatrick has been destroyed. In the old graveyard of Inch a most interesting church, which had a square-headed doorway, was removed to make room for the tomb of a local gentleman. At St. John's Point the western gable of a church has fallen which had a square-headed doorway. A country road has been made through St. Mary's of Ballaghanery, beyond Newcastle, but its circular chancel arch still stands on the fence above the road, protesting against the barbarism of its destroyers. In

these dioceses we are indeed very poor in such architecture. Any person who wants to study Irish architecture by coming here to-night has had an opportunity of learning much without the trouble of going through Ireland. I have very much pleasure in supporting the motion of Mr. Young.

Mr. Wm. Gray—Mr. President, allow me to endorse all that has been said in approval of the lecture. I am sure we ought to be extremely obliged to Mr. Milligan for bringing such a series of views before us. He has made very much use of them in endeavouring to draw our attention to ecclesiastical architecture—a matter which, as has been demonstrated to-night, is not the dry-as-dust subject it is generally thought by the community. He has referred to the introduction of Christianity into Ireland. I think the general impression is that Christianity was introduced about the sixth century; but we have in Ireland evidence of the existence of Christianity long anterior to that date. There are no buildings similar to many of those shown to-night in any other portion of Europe, and they demonstrate from their character that Christianity must have been introduced into the island long prior to the sixth or fifth century; otherwise there would have been no such superior buildings. Mr. Milligan referred to Cashel, and traced distinctions between one tower and another as evidence of their ecclesiastical character. I think when Christians came to Ireland first, they adopted the form of residence and conformed to the customs of the native Irish. It is rather a dangerous thing to be drawing several inferences from minute details. I have very great pleasure in supporting the suggestion of Mr. Young; although a little informal, we take it for granted that a vote of thanks will be passed.

Mr. Wm. Armstrong—I should like to ask Mr. Milligan a question. It is with regard to St. Patrick. He is said by a great many to have been buried outside the Cathedral at Downpatrick, and a gentleman told me a short time ago that numbers of people come there and take away the earth, and carry their fervour to such an extent that a considerable quan-

tity of earth has to be replaced every year. I think Mr. Milligan should let us know where St. Patrick was really buried.

Professor FitzGerald—I wish to emphasize what Mr. Gray and Mr. Young have said, and I think we are much indebted to Mr. Welch, who very kindly gave his services in exhibiting the views. Mr. Gray himself is not unworthy of thanks for the amount of trouble he took in the matter of the photographs.

Mr. Milligan.—In answer to Mr. Gray, I only gave it as Miss Stokes' theory regarding the round towers. With reference to the remark regarding St. Patrick's grave I am not an authority. On this point, I think Father O'Laverty would be the best authority in the room. In the annals and traditions of the country, however, Downpatrick is associated with the death of Saint Patrick. We know that the old round tower is destroyed, and we would hope that we may yet get the whole of Ireland to join together so that we may have a national monument to satisfy all classes of people; an old gentleman who died some time ago left the sum of £100 to form the nucleus of a fund for this purpose. I have only to again thank you for your patience, and to express the pleasure it gives me to appear before you to-night.

March, 1892.

Professor M. F. FitzGerald, B.A., C.E., in the Chair.

Dr. John MacCormac gave a lecture on

THE INFLUENCE OF LANGUAGE AND ENVIRONMENT UPON THE INDIVIDUAL THROUGH THE NERVOUS SYSTEM.

Dr. MacCormac said :—Much has been said and written in the present day about the development of physical characteristics by the surroundings or necessities of animate nature, and on the influence of heredity and environment upon individuality ; but it appears to me that sufficient stress has scarcely been laid upon the important agent in the process conveniently termed the nervous system. When we consider that every act which distinguishes animate from inanimate nature is dependent upon nervous influence, and that the pulsations of the heart, the inflation of the lungs, the perceptions of sight, sound, smell, and taste owe their origin to the wonderful system of nerves and nerve-centres, we may easily form some idea of the part they play in the economy of man. A celebrated physiologist has said—" If the knowledge of the structure and of the properties of the human body ought to direct the study of the phenomena of life, on the other part these phenomena, embraced in their entirety, and considered under all points of view, cast a great light on the properties which they show in action." These words should impress upon all earnest students of the various phenomena of human existence the absolute necessity of considering, not only the structure and mutual relationship of the various parts of the body, but also the influence of these upon his higher and nobler nature.

One of our most thoughtful writers has said that the best study of mankind is man, and by this he doubtless means, as we mean, that to study human nature is not merely to seek a full acquaintance with the various portions of man's frame and the duties assigned to each of his physical powers, but also the influence of the bodily on the mental faculties, and, by consequence, on the development of the individual character of each subject. For the phenomena of human life must be divided into two distinct classes or categories. (1) Those which appertain to man in his animal nature, and (2) those which tend to lift him above the level of the animal kingdom. To the superficial student the second division is very difficult of comprehension, and a popular but ignorant definition of metaphysics often provokes a smile. It is that the science of metaphysics is somebody trying to explain to another what he does not understand himself.

How external influences act and react upon the mental powers, producing certain characteristics in one individual and others in another, is imperfectly understood, but an investigation of some of these phenomena will certainly be interesting, and possibly instructive. Now, the influence of the organic powers, indicated by such names as temperament, general predisposition innate or acquired, functional troubles of nutrition, of wants and inclinations, are represented by the ganglionic nervous centres, while the influences of the physical world through the senses are represented by the sensorial nervous centres. But the influences of the subjective, or, as we may term it, the spiritual world, are represented by psychocerebral centres in which the ideas are severally imprinted with a distinct modification. These three harmonize and combine to produce all the phenomena of moral and intellectual life, and this conclusion sums up the anatomical and physiological formula of the phenomena of innervation and impressionability. These considerations show the great interest which naturally attaches to the influence of externals upon mind and character, and to the intimate relationship between the nervous system and

such immediate powers as language and environment. It is my hope, therefore, in presenting to you this evening some conclusions at which I have arrived, from careful observation of this relationship, to throw some light upon points which have hitherto not received much attention; and the order in which I shall ask your consideration of these will be :—(1) A few anatomical and physiological facts relating to the nervous system; (2) the influence of language, written and spoken, upon the individual through the nerves; (3) the influence of environment in one or two of its phases upon the individual in the same manner. In dealing with the first point I am compelled to be technical and brief, for to investigate the exact structure, relations, and functions of the nerve centres would require an elaborate and exhaustive treatise. It will, therefore, be, I hope, sufficient for our present purpose, with the aid of diagrams, to indicate the general relations and some of the functions of the nervous system.

The speaker then went on to offer a technical description of the nervous system, illustrated by excellent diagrams. In continuation, he said :—Such is a slight sketch of the nervous system, intensely technical, it is true, but, I venture to hope, sufficiently clear to enable you to understand the general drift of the remarks I have now to make. The next point that we have to consider is the influence of language, written and spoken, upon the individual through the nerves. Now, education, in its most elementary process, is a development of the powers of the mind, the higher faculties of the individual, by means of externals, through the senses, so as to enable him to benefit by the collected information in the possession of society. Instruction, on the other hand, in its simplest form, is the act of imparting knowledge to the rapidly-developing intellect. It is only then by means of signs, written and spoken, that this twofold process can be accomplished. As physical training develops and perfects the powers of the body and fits it for the various duties demanded from it by animal existence, so mental and moral training is essential to the proper develop-

ment of the powers of the mind, and powerfully influences the development of character. Both of these, indeed, would be impossible were it not for the influence and media of social tradition, language, and associations. A few moments' reflection upon the effect of diet and exercise, social intercourse, and the various requirements of ordinary life, together with the development of the arts and sciences, will establish the truth of this. An interesting point to be considered here, and ever borne in mind, is that instinct, as it is generally understood, in man has neither the force nor the duration of that possessed by animals. From the early period of infancy man's instinct is gradually effaced, rubbed out, as it were, by the quickly-developing powers of the mind, and it can be readily understood how low in the scale of being the human animal would sink, were the beneficial effects of mental and moral training denied to him. While the influences of language and environment cannot well be severed, for they reign simultaneously, and the power of one is manifested and exerted by means of the other, it is important to consider the part that language plays in the education of mankind. It must be considered, too, not merely as the instrument necessary to the reception and transmission of ideas, but also as a means by which the operations of the brain are facilitated and energized. In order to establish this it will be necessary to ask you to consider some general data. These we will endeavour to set before you as concisely as possible, without entering into the field of ideology. The phenomena of impressionability and innervation are the result of the operations of the nervous organism; they correspond to three orders of excitations, and are fed from three distinct sources. These are the visceral excitants, which take their origin in internal organs, and may be named affective or ganglio-cerebral; the excitants which depend upon the physical world through the organs of sense, which may be named sensorial or physico-cerebral; and the excitants which are under the influence of the moral and intellectual world through the intervention of the spirit, and may be called spiritual or psycho-cerebral. These are equal

in number, not only to the ideas expressed by the words of a language, but also to those which may be expressed by any combinations of such words. Hence, we find an abundant source of excitants, whose duty it is to furnish a considerable part of the operations and development of the nervous system.

But what is the ideogenic docrine held by physiologists? What the origin of the ideas of which society is in possession? It is admitted on all hands that these ideas are not only originated but disposed of, in the several operations of man's sensibility, understanding, and will. This is a matter of universal observation and belief. Between collective life and that of the individual, there exists a series of relations which the neurologist is bound to study. The mediation of the signs of language in the cerebral functions, as well as the moral and intellectual acts of man, are embraced in this study, for these are the result of an affinity, pre-established between the psycho-cerebral functions and the signs of language, and these signs are the appropriate figures of the mind, by which it acts upon the brain in order easily to discharge its function in the complicated acts of the understanding, and they not only furnish to the ideas a means of transmission and preservation, but, in addition, furnish to the psycho-cerebral operations an indispensable aid. Now, the psycho-cerebral organs, in their marvellous functions, demand in some way the mediation of these signs, just as the respiratory organs, in changing the composition of the blood, demand the mediation of air; just as the digestive organs in the process of nutrition demand the mediation of proper food; or just as the sensorial organs demand the mediation of colours, sounds, temperature, and resistance. Without speech, which really crystallises the floating vapours of ideas, and thus concentrates into form the acts of the mind, man might preserve a confused image of an isolated act, a vague notion or a hazy conception, but he would lack a form in which to recall it, an embodiment upon which the mind could rest. It would thus be impossible for him to acquire those ideas which concern the existence of the related deductions in his sensorial

sphere. These diverse ideas, so numerous and necessary in reasoning, are acquired and preserved by means of the word. The highest and noblest example of this is to be found in the narrative of Holy Scripture, where we find all the attributes of the supreme Deity concentrated into one form, and rendered intelligible to humanity in the person of the Logos, or Word of God. Though of immense importance, we simply content ourselves with recalling this, in expressing and emphasising this physiological law ; That in the complex phenomena of the moral and intellectual life of man, the concurrence of the organism is the result of the materialisation of articulated and figured signs of language in the brain.

We have now to consider the influence of education, by means of the signs of language, on the functions and development of the nervous system. This will enable us to account more easily for the various influences on the general phenomena of impressionability and innervation, which so powerfully affect the character of the man. In considering the signs of language in their relation to the phenomena of life generally, we have to observe (1) the acts of sensibility called animal ; (2) the acts of the understanding ; (3) the acts of volition ; (4) the acts of animal contractility ; (5) the acts of circulation, secretion, and nutrition ; (6) the acts of the development of the nervous organism ; (7) the acts of sympathy, impressionability, and organic contractility. I. The acts of sensibility are various, but, assuming that under the term sensibility may be included (1) sensorial impressionability, (2) affective impressionability, (3) consciousness, we may ask whether the sensations experienced by man would be possible apart from the notions acquired by language. This important question, we believe, can only be answered in the negative. Hence, man's sensation consists in the faculty of discerning and naming groups of confused impressions, in the faculty of applying acquired notions of time, space, genus, species, qualities of forms and colours, in determining different impressions. This sensation is active, and generates an operation like that in logic called a primitive judgment. To be con-

vinced of this truth, one must examine the numerous and divers impressions produced by a single object, when in contact with an organ of sense, and take into account the confusion which would result if man did not possess a power of unification by which he co-ordinates and transforms his impression into a distinct idea. For example, if a man be the object brought into contact with the organ of vision, a distinct conception would be wanting ; the impressions of position, form, colour, size, movement, and distance would be purposeless, because, striking the eye simultaneously, they are in like manner transmitted by the optic nerves to the visual centre in the cerebrum. Here these simultaneous impressions necessarily determine multiple modifications in the brain, which modifications can produce sensation by being reduced to a unity whose substantive man is the representative. When tactile and auditory impressions are added, there arises an increase of modifications, the combined result of which bears no resemblance to the distinct and unique sensation. The effect is not unlike the confused impressions which occur in dreams, and it is only when all these varied and manifold impressions are brought under a general name that we obtain a clear and positive sensation, an accurate mental picture, and can conceptively say—Behold a man ! This reasoning reminds us of the intelligent blind man to whom a careful and accurate definition of "scarlet" was given, and who, in reply to the inquiry as to whether he understood it, said, "Oh, yes, it is like the sound of a trumpet." He summed up in a single conception the sensations of which he was capable. Moreover, these considerations lead us to the conclusion that such conception largely depend upon previous instruction. We do not instinctively possess such ideas as those of stranger, friend, painting, book, or number, but the necessary accompaniment of earlier mental development is incontestable in the conception of such ideas. It is important to recognise that our activity reacts on the plurality of the cerebral modifications, which result from the plurality of these impressions ; that it invests them by means of language with the character of unity ; and

that this unity, which is neither more nor less than an idea, is a true conception. Now, this conception is not definitively an act of the spirit, as described by some philosophers under the name of perception, as distinct from sensation, as if to feel and to perceive were operations entirely independent of each other; and this is confirmed by experience. When the operator gives sight to a blind person, or hearing to the deaf, the resulting sensorial impressions would be confused and barren were it not for the embodied experience of a previous education. Though, perhaps, infinitesimally distinct in point of time only, sensation and perception are, therefore, one and the same phenomenon of human activity, originating in groups of sensorial impressions, and transforming them by the aid of a sign into an idea, or into a positive conception. We insist upon this point of doctrine, because it furnishes us with valuable information as to the number and extent of the cerebral operations—operations determined in man by the signs of language.

But this is not all. Sensation has not always the same extent or degree of intensity. When impressions reach us unexpectedly, they produce sensations less perfect than when they are anticipated. We are not contented in the last case with distinguishing and naming a group of impressions ; we go further, we detach one or more impressions from the whole, and name them successively—in other words, having formed a clear conception of an object, we then discern its parts and its attributes. In this way a botanist, in examining flowers that the horticulturist has often contemplated, sees organs, colours, and conformations to which the other is a perfect stranger. Similarly, a well-informed physician, in ausculating the chest of a patient, hears and understands sounds which few could either hear or comprehend. The explanation of this is to be found in the fact that there exist in the mind of these men qualities which possibly exist in others, but which, from want of training and cultivation, might just as well not be there. These qualities—concentration of mind and unremitting attention to the minutest details—have been developed by the aid of

preconceived notions, formulated and transmitted by language; and, thanks to the intervention of language, sensorial impressions in which we are passive need not be confounded with those in which we are active.

We have now to consider the intervention of language in touching or moving phenomena. The acts of affective impressionability are not generally defined with clearness and exactness, and too frequently the phraseology of the educated and the uneducated displays the same confusion. We often find emotions, sentiments, desires, and passions confounded. To avoid such inaccuracies care must be taken to analyse and correctly name the acts, after having discerned the causes which produce them. Now, the acts of affective impressionability must be distinguished into desires and passions, while passions are in reality desires beyond control. Instinctive appeals are simply veritable desires, while sentiments agree altogether with the emotions and desires. At the same time, emotions only come under this head so long as they are associated with desires. Thus pity, which is a sympathetic emotion, occasioned by the sight or the conception of an individual in pain or distress, is at the same time, a sentiment, because, if real, it is accompanied by a desire to assuage the pain or alleviate the distress. The more nearly an emotion approaches a desire, the more does it partake of the character of a sentiment. The affective impressions, which have for their object the preservation of the individual, are common to man and beasts. In man alone exist those sentiments which result from the educator which we call society. Such sentiments are those which induce love to God, humanity, country, and family, and make us chaste, charitable, and worthy citizens. Such are the sentiments, too, which impel us to seek glory, power, renown, luxury, and wealth, and which manifest themselves in our social life. Further, the instinctive appeals common to animate creation find in man, in the intervention of ideas by language, a source of energetic and persistent excitants wholly wanting in brutes. Thus, a word which designates a food, which characterises the

odour or savour of a particular dish, the remembrance of a repast, the name of a fruit, suffice to produce in man the group of affective impressions called hunger, or to recall the very flavour of a once tasted dainty. It is the same with other instinctive appeals ; and this explains why men are capable of excesses to which the brutes are strangers. Man during life is not merely impressed by the objects and events which come into contact with his sensorial organs, but also by objects and events beyond the range of his senses, in time and space. He has the faculty of being informed of the existence of acts, although separated by immense intervals, so that desires are generated, and consequently emotions, which bear the character of anticipation and memory. By this means subjects of the highest interest to our welfare are brought before our mental view. Such is death, the thought of which moves us most profoundly, and which inspires us with acute anxieties, for both our friends and ourselves. Animals, for aught we know, are exempt from these prepossessions, because they have not the ideas which we believe man alone can have. Still further, our moral and intellectual activity grasps not only the objects and ends which are without our sensorial sphere on the globe we inhabit ; it stretches far away beyond into the regions of the infinite, thus becoming at once a source and a support of religious thought through the psycho-cerebral excitants. Thus, in the cerebral operations of man are blended the traditions of the past, the social relations of the present, and the anticipation of that which is to come, uniting heaven and earth in the vast domain of human thought.

The next point that we have to consider under this head is the intervention of language in the acts of consciousness. By the knowledge of the result of our moral and intellectual activity, and also of our nervous impressionability, we appreciate the morality of our acts and sentiments, as also the effect of our emotions. Man is as conscious of pity and love as he is of lassitude and indifference. Now, to have consciousness of different affective states, it is necessary to have a previous idea,

and that each of these states should be perceived, discerned, and named. But have the brutes the consciousness of their impressions and movements? The commonly received opinion is that they have, but this arises from the error which makes the phenomena of human life intervene in the appreciation of functional operations in the life of brutes. When our activity remains foreign to the facts of impressionability and innervation, which produce them in our organism, we do not preserve the remembrance. Now, the remembrance here gives the measure of the consciousness that we have of our impressions and our movements. Take, for example, the instrumental musician who has become perfect in his art. Note the rapidity and precision of his movements, which at first were always accompanied with consciousness because produced with effort and close attention. Now there is speed and perfection without conscious effort, because they spring from a habit created in his organism. The same may be said of the skilled and rapid writer. The more the organism has been adapted by persistent application to perform certain acts, the less consciousness have we in executing them. Add to habit the fruit of previous teaching, the permanence of this knowledge by all the means employed in society and in the family; add, again, the notions representing the memory present in the mind; finally, add the physiological conditions created in preceding generations, received and transmitted hereditarily by the present, and you have abundant material to establish this position. In acts of the understanding, in acts of the will, in acts of muscular contractility, in acts of organic sensibility as influenced by the signs of language, if carefully considered and analysed, which unfortunately want of time prevents us from doing, we should find the same general result—viz., that the character of the man depends to a great extent upon the influence of language upon his nervous system.

The third and last division to which I have to ask your brief attention is the influence of environment, in one or two of its phases, upon the individual through the nerves. By

environment must be understood all the external influences brought to bear upon man in that sphere of life in which he is found. It is, however, only to that phase of environment known as social institutions or the influence of society, to which we propose to ask your attention for a few moments. The idea of the influence of such institutions upon the individual character is not by any means new, for writers, both ancient aud modern, have been struck by its importance. This is evidenced in the writings of Hippocrates, Galen, Polybius, Bodin, and Montesquieu, and it is, perhaps, by no means singular that, with his well-known powers of observation, the father of medicine, the illustrious Greek physician, should have entertained a conviction, though a crude one, that institutions, or, as he termed it, the government of a single person, affected the character of the people governed. But it is surprising that many able writers, in considering moral and intellectual man as the product of a fertilised organism through contact with physical influences, should forget the relations which exist between the character of man as wrought out by impressionability and innervation, and the teachings of tradition. These lean, too, entirely to the paramount influence of geographical position and physiological conditions. That these exert their due influence and weight in the formation of character, through the media I have described, is perfectly true, but it is not the whole truth, and I venture to hope that the points I have already submitted to your consideration will serve to impress upon your minds the important bearing of certain well-known facts in history, and that they will help to resolve one of the gravest and most interesting facts of human existence. The object of social institutions is to impress upon the mind of each individual of the tribe or nation the traditional customs and beneficial government of such tribe or nation, which customs are received, stored, and transmitted by means of language Under these may be united all the various means of education adopted by the nation, and these may be enumerated as religion and its institutions, political, civil, and judicial in-

stitutions, institutions which regulate public health and morals, institutions which have for their aim the diffusion of arts and sciences, and the general welfare of the people. It must not be forgotten that the acts and measures of every Government are assumed to be known and understood by every citizen, and that, consequently, the smallest unit of society, the family, or even the adult individual, must necessarily exert an influence elsewhere. The family cannot, therefore, isolate itself from society and its influences, any more than society can exclude the family from its pale. The one must consider the other, and the collective influence must be exerted upon the individual. In ancient Rome and Sparta, whose social activity was turned in the direction of conquest, public institutions exerted their influence upon the national character ; and physical force, energy, courage, and devotion to the fatherland were developed and stamped upon the people. Moreover, it is to be observed that if the same religious and political institutions prevail in two societies, whose physical circumstances and physiological conditions are dissimilar, these societies manifest a like development, not only in their moral character, but also in the impressionability and general aptitude of the people. Sparta and Rome on the one hand, Egypt and Hindostan on the other, afford examples of this. Again, if social institutions undergo a change in their character in the course of the existence of a nation, a changed moral character and impressionability are the result, though race and climate remain the same. The change in the character of the early Romans and those of the Empire affords a striking example of this. In explaining the cause of this change, I think we are bound to refer to the great alteration effected in their mode of government. The Senate, that venerable institution so worthy of respect and reverence, which by its wise and paternal government, had not only guided the national destinies, but influenced the national character, had lost its vital power, and became the mere tool and toy of weak or vicious emperors ; while low-born slaves had occupied positions of authority and vitiated all the

principles of good government. The ancient beliefs were undermined and sapped by the new philosophies, which unfortunately had but little power to influence the emotional nature of mankind. For want of such an influence, afterwards found in the spread of Christianity, the national character suffered a distinct and disastrous relapse. An irresponsible and immoral government speedily wrought its influence upon the character of the people, and a lack of stability and laxity of morals were soon painfully apparent. The history of mysticism, attributed by some to the character of the climate, by others to the action of assumed cerebral organs, also demonstrates this truth ; for the legal powers among the Hindoos having become vested in the priests, these, for their own purposes, interlarded and overspread them with their own mystic teaching. The consequence was that the exercise of power over the liberty of the subject, combined with a controlling sway over the mind, produced that slavish, superstitious mode of thought and character which it will take centuries of mental freedom to dispel.

Look again at the history of the Jews and the so-called Gipsy or Bohemian tribes. You find the same principle prevailing. However scattered they may have become, these tribes or nations, faithfully preserving their own peculiar institutions and their moral training, whether good or bad, always and everywhere manifest the same physiological and mental character. If, however, forgetting or departing from their own surroundings, their social environment, they are influenced by those of other nations, their distinguishing characteristics disappear, and others are developed. Again, in reference to suicide, which has been said to prevail among the denizens of hot climates. A study of this question reveals the fact that among those nations whose religious belief is fatalistic, it is practically unknown, whilst among others in the same clime, who are influenced by a different system, it is by no means uncommon. Such is the power of externals over the inner life of the individual. Again, take military bravery. This is not wholly due, as some suppose, to the character of the country,

but more largely to the institutions under which the people live. The village life of India, closely resembling the feudal organisation of the Celtic and Teutonic races, notwithstanding the enervating character of the country, has produced sturdy warriors, whose force the English power has felt, and now rejoices to utilise. Similarly it may be observed, as in Poland, Italy, and Switzerland, that people trained and nurtured under certain social influences or inspired by the educating contact of others, have manifested the truest and most conspicuous martial ardour. Again, look at slavery. Its influence as an institution upon the character of the individual through his impressionability and innervation is so well known that we only mention it in closing. Centuries of such an influence tell upon the mental power, so that unless some other force, such as education or Christianity, is brought to bear upon the subject race, the members of it are perfectly content to continue in a life of subjection and inferiority. We need cite no more powerful example than that of the Hebrews in the land of Egypt. The years of slavery had done their work upon the national character, for when Moses was called of God to lead them forth to freedom he found them but a horde of undisciplined slaves. External forces had wrought their influence upon them, for they had not only been robbed of their liberty, but of all sense of independent manhood. Under Moses they journeyed forth to freedom, but at the first reverse, like miserable caitiffs as they were, they cried to go back again to their flesh pots and their slavery. In course of time, under difficulties and a different social government, they emerged into a powerful nation, against whom no enemies could stand. From these remarks you will, I venture to hope, be able to see how closely the character of the individual is related to his nervous system, and how through that system, so beautifully, wondrously, and mysteriously fashioned, the powers of language and the environment of social institutions exert an all-controlling, powerful, and resistless influence.

Mr. Murphy—I have listened with much interest to the very

elaborate discourse we have heard from Dr. MacCormac on the connection of our mental culture with language, and the action of language and environment on the nervous system. In the prominence he gives to language, Dr. MacCormac has shown the difference there is between human life and animal life. We have not only the individual animal, and the individual man, each of them having a nervous system wherein habits are registered and character formed;—but, over and above that, man has the unique power of language, by means of which habits and character are stored up from generation to generation. We may approximately say that with the lower animals all habits are congenital;—their characters are formed at birth. But with man it is very different; the formation of man's character goes on through the whole period of life; and what makes that possible is language, whereby the acquired mental powers of one generation are stored up for the use of another.

Mr. Workman.—An idea struck me during part of the address of Dr. MacCormac. It seems curious when one tries to learn to ride a bicycle, there is a very considerable effort; I think, perhaps, an intelligent effort required to maintain the balance. When losing your balance you will require to take some means to recover it and maintain it, and that intelligent effort becomes exhausted in perhaps half-an-hour after you have had a dozen of falls of different degrees of force; and after the half-hour's mental exertion, you will find it quite impossible to continue the effort. After continuing this from day to day for a longer or shorter time, the mental effort seems to disappear, and after that there is left only the physical effort. Something similar occurs in learning a musical instrument, or a new piece of music. There is an effort to follow it out, and to acquire it as a habit; but when acquired, the mental effort ceases altogether. I must express the pleasure it has given me to listen to Dr. MacCormac's lecture.

Professor Fitzgerald.—Before asking Dr. MacCormac to reply to the remarks made by Mr. Murphy and Mr. Workman, I desire to express our thanks to Mr. Wallace for the loan of

the lantern, which is a very important thing to have on an occasion such as this. Some of the questions alluded to by Dr. MacCormac are certainly very old, for instance, how far conscience is an acquired moral instinct? As to another point which he brought forward, I believe that animals really possess to a very considerable extent the power of forming general ideas. All domestic animals can be made to believe that they are hungry, even when they are not, by talking to them about food; and I know most dogs can be made to feel quite sorry and melancholy if you speak kindly and pity them.

Mr. Workman.—Mr. President, before you ask Dr. MacCormac to reply, might I be so irregular as to make a remark? You suggested the possibility of a nerve centre starting up and fighting with you in your own system. I think we have specimens of that in persons of an undecided character who have a difficulty in coming to a decision on points generally, until Providence decides for them what they must do. You have in these cases two identities.

Dr. J. MacCormac.—My thanks are due to the gentlemen who have referred to my remarks in such a kind and flattering manner. I think Mr. Murphy entirely agrees with all I have said. And with regard to Mr. Workman's reference to cycling and the attendant exhaustion afterwards experienced, I think that can be readily explained by considering the condition of the muscles. It is quite easy to comprehend and explain the great exhaustion felt after a certain amount of muscular action; because, we must remember, we have not only five senses, as is commonly understood, but we have also a sixth—a muscular sense—which is just as distinct as our sense of sight, for example. And I think all that has been explained in a measure by what Mr. Workman has just stated. With reference to the observations regarding the ganglia, I think we too frequently see the evil effects of one nervous centre being over-stimulated, or educated, to almost the entire neglect of the other nervous centres; and in this present day of education, a great fault is to be found in the training of the young. Take for example, an

individual born with a genius for music, and who may perhaps be brought on a public platform to perform at the age of five or seven years. In such a case, the special cultivation of the faculty for music is adopted, to the entire neglect of the other faculties of the brain, and with what result? We very often find that in ten, twenty, or thirty years that same individual becomes an inmate of a lunatic asylum. I think that instead of educating a child exclusively in, say music, it would be well to restrain the tendency, and to give the child, as it were, an all round education, say in mathematics and other branches, and thus save it from the dreadful probability of insanity. My thanks, I may also say, are due to the audience for the kind attention paid to all my observations, which were unavoidably of a technical nature. And I cannot sit down without tendering my best thanks to Mr. Wallace for the admirable manner in which he has represented my photo. slides on the screen.

The HON. SECRETARY (Mr. R. M. Young, B.A., M.R.I.A.) announced the following donations:—The volunteer sword, worn by Henry Joy M'Cracken; presented by M. Christopher Aitcheson, J.P., Loanhead, Midlothian. An ornithorhyncus, garnet rock from Alaska, silver ore, Chinese opium pipe; presented by Captain Robert Campbell, ship Slieve Donard. A large carboniferous fossil shell, *productus giganticus;* presented by Mr. John Wilkinson, Comber Place, Belfast.

A vote of thanks was passed to the donors, on the motion of Mr. ROBERT YOUNG, C.E., seconded by Dr. P. MACAULAY.

9th March, 1892.

PROFESSOR M F. FITZGERALD, B.A., C.E., in the Chair.

WILLIAM GRAY, Esq., M.R.I.A., read a paper on

THE ESSENTIALS OF HOUSE SANITATION—HOW TO SECURE THEM.

MR. GRAY said:—The subject of the evening may be expressed by the one word, "Cleanliness," and, as this might be too concentrated a form of an expression for a text, I will amplify it a little, and state that the essentials of House Sanitation consist in "The immediate and thorough removal of all waste products."

I will consider this proposition with special reference to three points, A, B, and C, suggested by the following anecdote: An Irishman had a very defective grate, which, like too many others, wasted the fuel, and gave little heat. After considerable hesitation, he yielded to advice, and went to a tradesman to get a new grate. The tradesman, dilating on the qualities of his wares, very strongly recommended one grate in particular, because, as he said, "It would save half the coal." "If that's the case," said Pat, "I'll just take two of them, and save the whole of it."

Here we have an illustration of what generally takes place with the public, in dealing with sanitary matters. In the first stage, the public are very apathetic and hard to move; in the second stage, when they stir, they fall under the influence of business push, and are perplexed by the multiplicity of suggestions from engineers, doctors, and manufacturers. In the next or third stage, they need the sole guidance of common sense.

We should, therefore, consider the matter with special reference to the three points—A, Apathy ; B, Business ; and C, Common Sense.

This sanitary question is not a purely moral one, and yet it is one that involves very serious moral responsibility.

The health of body and mind—that is, our physical and moral well-being—is powerfully influenced by our surroundings. "Cleanliness," says the proverb, "is next to Godliness." If so, the development and maintenance of religion and morality, as well as the personal comfort of every individual, depends in some degree upon the cleanliness of our persons, habits, and dwellings; we may take for granted that physical impurity is the emblem, if not the sign, of moral impurity; hence the importance of sanitary reform, from a moral point of view. Clearly it is every individual's duty not only to try and preserve his own health, but he should take care that by his person or habits he is not the cause of disease to others. This being our double duty, we should at once look to the sanitary condition of our dwellings. We are too careless on this point, because our daily observation proves that there are hundreds of cases exposed to obviously unsanitary conditions, and no evil effect seems to follow ; the connection between a particular case of disease and a defective sewer cannot always be traced to the satisfaction of the ordinary observer. This is so. Nevertheless, we should remember that germs are not always matured at the spot on which they were generated. For example, the thistle-down originated on one farm may be matured into plant and flower in a distant townland ; and the fern-spore shed in the moist and shady valley finds a lodgment, and develops into feathery fronds, in the crags of the mountains. So also with the germs of disease ; they may be nursed into being in the close alley or filthy court, but they may bring forth their deadly fruit in the luxurious chamber of the suburban villa. The owner of the villa and the lodger in the alley therefore are each dependent one upon the other, and are equally bound to further every effort made for the promotion of sanitary reform.

In a large manufacturing city like Belfast, where there are miles of streets composed of the houses of the working classes, it is of the utmost importance that we should look to the sanitary condition of our workers' dwellings. Belfast is not so badly off in that respect as many other towns, but yet much remains to be done towards removing the defects left us as a legacy from the past. Had the founders of Belfast settled about the skirts of MacArt's Fort, as the old Danish founders of Dublin settled around the Celtic fort on which now stands the Castle, our Borough Engineer would not have so much difficulty with the city drainage, and our Medical Superintendent of Health would not be so anxious about the high death-rate. The residents cannot now remove to the Cave Hill, but they can do much effective work towards removing other defects left them from the past. Fortunately our workers are fairly provided with self-contained houses, unlike many of the houses in Dublin, where several families dwell in one house—I have heard it said that in some cases several families occupy one room. In one such case the members of the little community got on very well, until one of the families began to take in lodgers. Fortunately there is none of this in Belfast; every family can have a separate house, imperfect as it may be in many respects. I have visited many of the workers' houses, and have been shocked at the deplorable condition of the surroundings, due, not only to structural defects, but to the apathy and downright carelessness of the inhabitants. This is our point A—Apathy, for which there is no excuse. Every householder should protest against every form of structural defect, and aid the authorities in getting them remedied.

Let us examine the structural defects, and they come directly under point B—Business. The speculating builder often, with a false economy, fails to provide the necessary appliances for keeping the tenants' houses reasonably clean and healthy. One serious defect is the manner in which the bell-trap and cesspool below it are constructed. Most of the yards are nominally trapped by this exploded contrivance. I say

"nominally," because the so-called yard trap is but a trap in a very equivocal sense. It does not trap off the foul air, but it entraps the poor worker into the idea that it does. You will find that the yard trap is a loose metal contrivance that collects all kind of filth in and about it, thereby failing in one elementary principle, namely, "the thorough removal of filth." Lift it out of its timber frame, and you will find a filthy receptacle below it, and, above all, you will find that the open mouth of the town sewer is belching its foul and poisonous breath, to blanch the cheek, check the vigour, and destroy the health of the humble household. A contrivance of this kind is in direct violation of the elementary laws of sanitary science, for it not only creates a mischievous local pollution, but it freely admits the town sewer gas. Where this is so, I would strongly recommend the tenant to call upon his landlord to remove the abomination, and to substitute a glazed earthenware trapped gully, properly connected with the town sewer, so that at all events from that point there need be no fear of sewer gas. Another defect is the badly-paved yard, with a broken and irregular surface, saturated with accumulated filth. Every yard surface should be solid and impervious to fluids, and the even surface should have a quick fall to the trapped gully, with no corners, or hollows, or other catchments for filth, so that a bucket of water can wash the surface with an "immediate and thorough" discharge.

Mr. Gray then pronounced his strongest condemnation of another defect—the common open privy; and proceeded:—In the country, where the free air of heaven scatters the foul air and counteracts the influence of the unhealthy and deadly vapours, the common privy may be tolerated, but in towns like Belfast, where dwellings are crowded into narrow spaces, it is wrong for the health authorities of the town to allow the continued use of the common open privy, where animal and vegetable refuse create the most deadly forms of disease. It is almost criminal for any tenant in Belfast to occupy a dwelling that has not a properly trapped closet, with a good water flush. Manufacturers

have produced a variety of cheap and effective closet that leave builders of small house property without excuse, and yet there are hundreds of small houses in Belfast that have no other convenience besides a common open privy, producing the most offensive sight and smell. The only excuse offered for this serious defect is, that owners of small house property find that their tenants misuse or woefully destroy any breakable apparatus provided. For this neglect or damage there surely should be a remedy.

Attached to the privy, there is the no less dangerous open cesspool or dust-heap, exposed alike to sunshine and to rain, as if intentionally to facilitate the decomposition of the filthy compound, and to generate the microbes that find rest and culture on the top and surface of the badly-built yard walls, saturated with wet and disintegrated by frost. The danger from this source begins when the refuse is allowed to remain beyond a week ; and yet it is often allowed to remain not only for weeks, but for months. I have seen rows of such houses, back to back, with a common passage between them ; and this passage, instead of being a clear place by which the refuse from the yard is regularly removed, is itself the common receiving-place for all kinds of impurity, from the over-filled manure pits of the several neighbouring houses. Here I have frequently looked upon broken crockery and old clothes, dead cats and cabbage stumps, bones and bottles, chimney sweepings and discarded headgear, old shoes, boots, and brickbats, and, over all, careering before the wind, the loose chaff just discharged from a used-up bedtick, on which, perhaps, some poor invalid had recently died of an infectious disease. Let any ordinary observer examine for himself the several items described, and he will have no difficulty in coming to the conclusion that the present state of large numbers of our workers' dwellings must be injurious to health, and that, as a rule, no proper provision is made for the personal comfort of the inmates, and that, therefore, no encouragement is given to those who desire to be neat and cleanly in their habits. It is essential that every

working man should have a water-closet, a trapped gully in the yard, and a movable receptacle for refuse, in addition to a separate water supply for domestic purposes. All solid refuse that is not removable by the drains should be deposited in a movable receptacle, to await the dustman's collecting cart.

Let us now inquire, is it possible to have all the defects referred to altered? And, if so, what is the remedy? At the outset, take for our encouragement the opinion of Arthur Cohen, Q.C., M.P., who states :—" So far as the structure and condition of the houses of our poor are concerned, the evils which have been described in language so powerful and graphic, and which undoubtedly exist, might all be removed by the exercise of legislative provisions which at this moment are contained in the statute-book. Indeed, it is extremely difficult, if it is possible, to detect a single blot in the social condition—so far as their dwellings are concerned—of our poor, for which their does not now exist a statutory remedy."

We have here a distinct reference to the sanitary acts, which provide for the removal of everything—structural or otherwise—that may be injurious to health. This reference involves the duty of the landlord, the tenant, and the sanitary authorities respectively. The landlord or "owner" is defined as the person who receives the rent for the time being, whether on his own account, or as agent or trustee for any other person. The tenant is, of course, the immediate occupier. The sanitary authority is the City Council acting through its sanitary department, which "is responsible for providing that all drains, water-closets, sinks, lavatories, gully traps, earth-closets, privies, ashpits, and cesspools within their district, be constructed, trapped, covered, ventilated, and kept so as not to be a nuisance, or injurious to health." (See a Digest of the Public Health Act, 1879, by W. D. Wodsworth, Assistant-Secretary, Local Government Board.)

The local authorities are bound to see that the premises are properly constructed as dwellings, and therefore they have to deal with the landlord or owner; and they must also see that

the premises are kept in a proper sanitary condition, and therefore they have to deal with the occupier or tenant. Unfortunately, the apathy of the landlord and the carelessness of the tenant present serious difficulties to the carrying out of the law.

I have the greatest satisfaction in referring to the great improvement which has taken place in the health of the city, and this is due in great part to the untiring energy on behalf of the people's comfort and happiness, which has been, and is now being, exercised by the Corporation of Belfast. The Sanitary or Health Department is under the management of the Sanitary Committee. The Medical Superintendent and Executive Sanitary Officer merit all praise for their zeal, courtesy, and forbearance under very trying difficulties. The manner in which the duties of this important department is carried out is creditable to the public officers ; and it is the duty of all right-minded citizens to do all in their power to assist the officers of health in their laborious and responsible duties.

In dealing with this matter, I should not omit to refer to the very excellent rules of the Belfast Town Council, with reference to that and all other classes of buildings, and I think I may safely affirm that if the rules drawn up by the Council were honestly carried out, the result must be a substantial improvement in the general health of the city, for under them no dwelling need be in an unsanitary condition for the future. The greatest difficulty will be in dealing with the older houses, badly built at first, and now so "run down" in condition as to render their proper repair unremunerative ; but no tenant need suffer, for all reasonable complaints will be promptly attended to by the sanitary officers of the City Council.

Another very great difficulty is in dealing with the careless and slovenly habits of too many of the families of the working classes, no doubt due in a great measure to the training, or want of training, in our ordinary National Schools, and to the very questionable sanitary arrangements with which they are provided.

It is a national disgrace that the great majority of our National Schools are unprovided with yards or offices of any kind ; and, where they are provided, they are most commonly of the very rudest description—filthy, dark, and small,—unless in vested schools, built under Crown grants, of which there are too few. No wonder that the children of our working classes are brought up with degraded notions of personal decency, or the value of cleanly habits ; and that when they come to be heads of families, or servants in private houses, they think so little about their sanitary surroundings, or the duty that devolves upon them to aid the public authorities in providing for their health, comfort, and happiness. The value of improved artisans' dwellings properly cared for, has been proved to have the best results on the health of the places where they are provided.

The improvement made in artisans' dwellings, in London and elsewhere, has helped very materially to reduce the death-rate. In 1881, when the city death-rate was 21·2 per 1,000, the death-rate in the workers' dwellings erected by the Peabody Trust was 17·2. The rate in the buildings of the London Improved Industrial Dwellings Company was 16·4 ; and in the dwellings of the Metropolitan Association, 14·3. In Newcastle, when the death-rate was 22·2 per 1,000, the rate in the improved industrial dwellings was only 12 per 1,000. Such buildings can be provided under the Housing of the Working Classes Act, 1890, under the provisions of which any individual or company can obtain financial aid from the Government, for the purpose of facilitating the erection of suitable dwellings.

It would be a very serious mistake to think that the dwellings of "the better classes" are "better" than the dwellings of the working classes from a sanitary point of view. Not at all. In many, very many of our superior dwellings, in which all is bright with tinsel and varnish, there are as defective sanitary arrangements as elsewhere, and it is as incumbent upon the tenants of such houses to see to their sanitary surroundings as in any dwellings of the poor ; and yet such tenants are as apathetic as their poorer brethren in looking to the sanitary

arrangements of their dwellings, and, therefore, all that has been said with reference to the smaller houses, applies with equal force to the houses of our middle and upper classes. It cannot be too strongly impressed upon householders, rich and poor, that their personal health, the health of their families, and consequently the health of the community at large, depends upon the care taken by each individual to secure the proper sanitary condition of his own dwelling. And any householder who does not see to and understand the sanitary arrangements of his own house, may rest assured that such arrangements are defective and dangerous. All that is essential for the sanitary condition of any dwelling is so simple, that the arrangements can and should be understood by every householder.

Mr. Gray then described in detail the principles of his text, and their application to the dwelling.

If effective sanitation requires the "immediate and thorough removal of all refuse matter," it is quite clear that all receptacles of such matter should be placed as near the outer air—that is, the outer wall—as possible, so that the channel liable to breed pollution should be as short as possible. The closet and the bath and the scullery slop should be next the outer wall, and discharge directly through the wall into the open air. If this is done, the plumber's work is made easy, and without complication. Do not have the discharge end of the bath turned from the wall, with a waste running its entire length under it. Let the closet discharge directly through the wall, and not by complicated bends from an inner wall. The same may be said of the scullery waste. Further, that the discharge may be thorough, let the outlet be ample.

Mr. Gray described the ordinary defective methods of discharging slops and baths through limited apertures, recommending a much more open vent, so as to secure a scour for the outlet drains, &c. He exhibited and described a special form of waste made to his instructions, which gives such a good flush as to discharge the waste quickly, and carry away all soap, and prevent its lodgment in the pipes. This brass plug gives a full

bore flush, and yet, by a movable cage, checks the inlet of solids and gives access to the trap. The same arrangement is applicable to other forms of slop waste. He described the best methods of immediately and thoroughly removing the contents of closets, and recommended for this purpose a simple form of wash-out closet, the details of which he fully described, dwelling chiefly upon the points most essential for the effective working of the apparatus. He strongly condemned the old pan closet, which cannot be free from local pollution, and warned householders against the push of interested manufacturers, who recommend costly apparatus involving no essential principle that is not fully met by a much more simple form of closet ; and the more direct its discharge is, the better. We have still a survival of the old system in the downward bend from even otherwise good closets. The discharge should not be downward within the house, involving further bends. The discharge should be through the wall direct, and if possible above the floor line, and accessible, the pan to have a good 3-gallon flush. The full flush secures the "immediate" as well as the "thorough" removal into the open air.

Having shown how the liquid and other refuse should be "immediately" and "thoroughly" passed into the open air, he traced its further passage into the town sewer through a trapped air chamber. This trapped air chamber is absolutely essential, and must not be dispensed with upon any account. This was very fully described and illustrated by diagrams and models, many of the latter showing the unnecessary complication before the public, and the necessity for exercising common sense in their selection,—above all, to see that the air chamber is freely open, and that the trap is accessible. This air chamber, trapped at the town side, should, if possible, be the receptacle for the soil pipe and waste from the scullery and bath, so that the water in the trap may be kept changed, and not allowed to become stagnant. With this arrangement there is very little fear of sewer gas. There may be bad effects from the local pollution which carelessness may allow to occur at the

house side of the disconnecting air chamber, but no sewer gas can return. This is absolutely essential, but will not be a protection from carelessness or the want of supervision.

Referring to the various complicated devices adopted with the view of ventilating the soil pipe, Mr. Gray expressed the opinion that far too much is made of it. It is a survival of the old closed-up system, when the sewer gas had direct access to the soil pipe ; but now no such gas can get to the soil pipe by a disconnecting trapped air chamber. The only pollution now possible in the soil pipe is the local removable pollution of the soil pipe itself. Mr. Gray said that the legitimate outcome of our present system of trapping and rendering accessible all apparatus, points to the possibility and the desirability of making our soil pipes removable, and accessible for cleansing directly, thereby avoiding the costly and unsightly vents, so strongly recommended under our point, B.

In dealing with this matter of sewer gas, Mr. Gray said it is strange that we should go to so much trouble to trap off every possible whiff, and adopt costly and awkward-looking contrivances to ventilate the limited soil surface of our soil pipes, in which there is no sewer gas, while yet we freely admit the sewer gas itself into our public streets. We trap our side gullies, and for this purpose adopt costly apparatus at each side of our thoroughfares, and yet we carefully place in the centre of our tramway lines, open ventilators that belch forth the blasting and deadly sewer gas without let or hindrance. Something must be seriously wrong with such an arrangement ! Surely, if it is so necessary for us to trap off our house drains, it is equally desirable to adopt some system by which our main sewers may be ventilated, so as not to poison and pollute the atmosphere of our public thoroughfares !

Before we can say that our drainage is passed safely beyond our premises, we must see that the drains carry without leaking, and that the ground itself is not saturated by drainage from our own drain or any other source. Mr. Gray described the necessity of having a solid bed for the reception

of drains, the method of making drain joints, and of forming an impermeable surface below the dwellings ; and strongly recommended that all drains should be accessible and under the control of the householder, who should make himself familiar with all the drainage arrangements of his premises, and see that they are kept in an efficient and cleanly manner. No amount of apparatus will make up for the want of intelligent supervision or common sense. He proceeded :—I am glad to see that the ventilation of our main drains has been taken up by the Town Council, and is referred to in the highly-important and valuable report just issued by our excellent local medical sanitary officer. We have all more or less benefited by the very excellent show room of the gas department of the City Council. It would be an advantage to the cause of sanitary reformation if the very excellent and zealous officer of the sanitary department would follow the example shown by Mr. Stelfox, Engineer of the Gas Works, and get together a showroom or exhibition of sanitary apparatus, so that the citizens might see for themselves the fittings and apparatus most approved by the authorities. In addition to this, the medical officer should keep on exhibition, for each month or quarter, a skeleton map of the city, showing the localities where disease prevails. In suggesting such a map, I do not mean anything more significant than that it should show the main outline of this city without details, so that the cause of disease could be more readily localised. Everything that pertains to health should be exhibited, and every facility given to the ratepayers to see what is being done in a sanitary way.

The lecture was illustrated with diagrams, models, and experiments, and the following discussion followed.

Dr. Lindsay—I did not expect that it would fall to my lot to open this discussion, but I have pleasure in doing so. I listened with great satisfaction to Mr. Gray's paper, and watched his demonstrations with interest. He has chosen a subject of the utmost importance, and I think he has handled it very satisfactorily and very intelligently. There is hardly anything in

his paper to which I can demur, except it be his comparison of the germs of disease to the fairies. Mr. Chairman, I have never seen a fairy, but I have seen the germs of disease, and if Mr. Gray is in doubt as to their existence I shall be very happy to show them to him at any time. In Belfast we have much too high a death-rate, the two principal causes of which are (1) the condition of the sub-soil, and (2) the occupations of the people. We cannot do much to modify these, but no doubt other conditions, such as house sanitation, can be modified. I thoroughly agree with Mr. Gray that what we need above all things is to arouse public interest and attention. How exceedingly simple are the principles of house sanitation ; they lie in a nutshell. They are the merest A B C work : the great trouble is to get them applied. I hope all here will remember what Mr. Gray told us to-night, that we already have the powers. The Public Health Act puts it in the power of every householder to compel his landlord to put his house in a good sanitary condition, and it is our own fault if we allow these matters to be neglected. Two very important points are to have proper traps and sufficient flushing. If these are in good order most other things take care of themselves. We ought to go in for a four-gallon flush ; some houses have very much less than two gallons. We very often overlook the fact that the materials in the trap may themselves give rise to gases, but that can be prevented if flushing is adequate. The condition of the jorbox is much neglected. I am greatly struck with the prevalence of typhoid fever amongst domestic servants, and I believe that this is partly due to bad gases passing into sculleries from the jorbox. Apart from the question of actual disease, it is one of our maxims when we find people never well that it would be a good thing to look to the drains. No doubt breathing bad air is one of the most potent sources of being constantly more or less in a low condition. We should have some means of compulsorily inspecting houses. As far as I know there is no public authority for anything like a regular inspection of houses. There is nothing more astonishing than

to find, when even the best houses are inspected, how constantly the drains are defective. It is almost an exception to find things right, and that even in new houses in the best parts of Belfast.

Mr. Conway Scott—I have listened with great pleasure to Mr. Gray's address. Although I agree with a great deal of what he said, he seems to forget that there are such people in the world as indignant ratepayers, and if we carried out all his suggestions I am afraid the ratepayers would be up in arms. As your governing body are elected by the people, they must act according to the wishes of the people who elect them. Mr. Gray has mentioned back passages; that whole question was before the Corporation fifteen years, but it was only last year that it took any practical form. After all, these things cannot be done without £ s. d., and as soon as the ratepayers of Belfast are willing to have all that Mr. Gray wishes done, I am certain that the authorities will not stand in the way, but say go on and prosper. The difficulty is the increased taxation. Dr. Lindsay made some remarks, which I agree with, about flushing cisterns. A two-gallon cistern is insufficient, but the bye-laws of the Corporation and the Water Commissioners permit them. The authorities are not to blame in the matter, as they had not sufficient water at the time these bye-laws were made to justify their saying "we will have only three or four-gallon cisterns"; and no sanitary officer can go beyond the law even to meet the requirements of Mr. Gray. Regarding Dr. Lindsay's remarks concerning the inspection of houses, if every ratepayer wishes to have his house tested once a month it would require an army of inspectors. At present any ratepayer within the city can have his house examined by sending a post card, and I do not think the Sanitary Authorities can go any further at present. As to Mr. Gray's remarks about traps, I don't know that Mr. Gray's new trap is very much of an improvement. He seemed to have the idea that nothing goes into the drains except water. Everything has been taken out of the Belfast sewer, from a child to old clothes. The careless

householder will throw anything down the drains. If he has any rubbish this is the convenient place for it. In reference to the idea of fitting water closets into small houses, I quite admit that the old system is a defective system, but to put water closets into every small house where they wonld be damaged and choked up would be a great mistake. In arranging accommodation for small house property you really should get something that could neither be pawned, nor sold, nor burnt. Mr. Gray referred to the ventilation of sewers: that is a very peculiar subject. If you ask the opinions of the most prominent sanitarians in the large English towns they will tell you that the open gratings are the best. I do not agree with that, but still you find a preponderance of opinion in favour of them. The Belfast Corporation are still pursuing the policy that where any owner of property will give them the use of a gable they will put up ventilator shafts. I am of opinion that as far as possible the sewer atmosphere should be carried up above the house levels, and I think in this matter the Corporation are doing everything possible. On the whole, I must congratulate Mr. Gray on his paper, and I think that such discussions are beneficial, as the more the public know of these matters the better.

Mr. Lockwood—I fully agree with the majority of Mr. Gray's statements. Sanitation in its main principles is very simple. We should first of all get the waste products out of the house as fast as possible, and keep them, or any part of them, from coming back again. Regarding the ventilation of the street sewers, Mr. Scott has stated what I believe is the case, that a very large number of authorities in different parts of England have agreed that the open street gratings are on the whole the best thing. I think, notwithstanding, that we should all be inclined to agree with Mr. Scott that it would be better if we could get some simple and workable plan by which these could be done away with, or simply allowed to remain as inlets for fresh air. If we can do this we shall, I think, have made an advance. There appeared recently a very interesting com-

munication from some engineer in a London professional journal suggesting that these gratings at the street should be all replaced by valves opening inwards, something like the valves which we now put in chimney breasts to ventilate our rooms, the exits to be only at certain selected spots where shafts might be erected. Mr. Gray and Mr. Scott also suggested a tall shaft, and if the Corporation gas or other cheap fuel can be utilised to create a strong draft there, the combustion will destroy all the foul products of the sewer, and you will have a quantity of fresh air passing in at all these valves and passing out purified at the chimney. Mr. Gray has further referred to the condition of our workers' houses, and especially to those in the older parts of the town. Superficially you may say that these houses generally conform to sanitary rules : that is, they are absolutely disconnected from the drains or sewer, but although the house itself is disconnected and the jaw tub is discharging over an open grating, yet the yard itself is so close to the house and so small that the very imperfect trap often gets filled up, and practically might as well discharge into the house itself. You will find also that in nearly all these houses the tiling and paving are very defective, and the whole sub-soil at the back of the house is in about as bad a condition as can be. I can also confirm what Mr. Gray stated with regard to the back lanes ; it is high time Mr. Scott steps in and has them cleaned. I know, however, from my own personal knowledge, it is not his fault if some of the right things have not been done sooner.

A gentleman in the audience asked Mr. Gray if he attached any importance to the question of wall paper in houses as dangerous to health, as arsenic and other impure ingredients are often used in its manufacture.

Mr. J. Brown—Mr. Gray has referred to the regulations of the authorities in Belfast respecting houses. I have not seen these, but should like to ask whether they have anything to say to the ground on which the houses are built. I refer specially to ground, which I observe in more than one place, being made up of rubbish from ashpits and other refuse of that kind.

Another question that might naturally occur in considering house sanitation is, What becomes of the sewer gas? Supposing there are 50,000 houses in Belfast with 50,000 pipes all pouring out poisonous matter into the air. Would not the whole of Belfast have been probably poisoned long ago if this were not got rid of? Does the air act upon it by oxidation, possibly by means of that more active form of oxygen, ozone, which the late Dr. Andrews found in certain quantities in the wholesome air of the country, but to a much less degree in town air. Is this deficiency in town air because the ozone is used up in oxidizing organic effluvia? If so the wholesomeness of country air may be due to its ozone. On the other hand however, Dr. Andrews showed that ozone in larger quantities is poisonous, and it is therefore difficult to know just how much is good for us. However, I want to direct attention to the fact that if this aeration of sewer gas destroys its poisonous quality, proper ventilation in our houses is of paramount importance; and I would suggest a system of ventilation different to what we usually have in ordinary houses. At present, ventilation, especially in winter, is really an accident not intended by the architect, and depends chiefly upon the action of the open fireplace with its chimney sucking air out of the house and producing a partial vacuum in the house, thus causing everything outside to try to flow in. Cold air dubbles through chinks in windows, ground air rises through the floor, and sewer gas is sucked in also where possible. Now, if we could devise some means of pressing air into the house instead of sucking it out, we should get rid of these difficulties. There could be no drawing in of foul gases; on the contrary these would be driven out. It must be left to the engineer, I suppose, to devise means for a system of ventilation under pressure, but something analogous to the wind-sails or ventilating cowls on ships, down which the wind blows into the interior of the vessel, might be practicable.

Mr. Edward Winnington—The instructive lecture to which we have just listened has been spoken to by the medical pro-

fession, and by the architects, and I now wish to speak as a plumber—I may say as a master plumber. Mr. Gray did good in drawing the attention of the public to the insanitary condition of some of our National Schools, as there is one at least, not very far distant from this place, where the means of the people would lead you to expect a different state of things, where the sanitary arrangments are, to say the least of it, most ridiculous and far from what they ought to be. I cannot agree with Mr. Gray that the pattern of bath waste which he has exhibited would be an improvement on that generally in use. In the modern bath the waste is placed in an enclosure at the lower end of the bath, the outlet being close to but not in the bottom, and with perhaps two or three bars across it to prevent anything passing down that would stop the waste pipe. The water is all drained off, leaving nothing perceptible in the bottom. Mr. Gray's suggestion with reference to placing the waste of the bath convenient to the outer wall, instead of as at present being fixed the opposite way, is a great improvement, and it is a wonder we did not think of this sooner. The old pan water closets are now out of date ; but with reference to the flush of the closets which are being used in their stead, I agree with some of the previous speakers that there should be a flush of four gallons, as three gallons will not always effectually cleanse the apparatus. I do not quite agree with Mr. Gray that water closets should be always placed at the outside wall of the building; they should be placed there if convenient, but it is possible to fit up this apparatus so that it shall be free from anything of an obnoxious character, and we must have it in a convenient and comfortable place. The lecturer did not mention any of the methods of testing, nor explain whether he would have recommended the " smoke test " or the " peppermint test." The smoke test is the popular one, but architects are not agreed that it is the best one; perhaps in his reply he can give us some information on this point. I have no sympathy with the recommendation for the formation of a " sanitary exhibition," but rather think it would divert

trade out of its legitimate channels; and I believe that personally Mr. Stelfox had no desire to open an exhibition of gas apparatus such as the Corporation have done, but he was obliged to do so because no house in the city in that trade could afford to keep a stock sufficiently large, and give it out on terms to suit the people, as they have done. It is not the same, however, with sanitary fittings, as there are many of the plumbing establishments in the city who are keeping all these fittings of the newest and best description. We have been favoured during this winter with a series of lectures in this place on the "Health of our Homes," and now this paper of Mr. Gray's, all showing the importance which is attached to this subject by eminent men, but they have left us at a point without providing for having their recommendations carried into effect, and this cannot be done except by competent and tried men. For this purpose I would direct your attention to the important subject of the "National Registration of Plumbers," under the provisions of which you have a list of capable and qualified men to whom you may entrust your work with a reasonable expectation that it will be properly attended to and done. I make this reference to the "Registration of Plumbers" with some confidence here, because that you, Mr. President, have taken such an interest in this movement, and have given it your hearty sympathy and support since its first introduction to our city.

Dr. Macaulay—I have had a little experienc with regard to the sanitary condition of the city. I have known myself (and I think Mr. Scott is also aware of this) that in some houses where the supposed sanitary improvements have been introduced disease has entered, and in some houses where there have been no sanitary improvements at all disease has not entered, so that probably we are in error in these sanitary matters. I could instance the case of a district which is now about to be cleared out, away near Carrick Hill, Birch Street, and Pepperhill Court. I am assured by the sanitary inspector of this city that, whilst in our suburban villas there were diseases, in the district around Pepperhill Court there were no zymotic diseases whatever. I was very much pleased with Mr. Gray's observations

about what I may call the effluvia pipe. I don't at all agree with the fitting of these pipes. I was very much struck with an observation from a gentleman of experience, that he thought that effluvia pipes were made merely to satisfy the imagination of the householder and not for any practical purpose, because he was informed by a gentleman well versed in chemistry that noxious gases have not the power to ascend, and that they are weightier than the air. If this be a fact, I think it would answer Mr. Brown's question, where does the noxious vapour go to when it gets up to the top? I may safely tell him that it never reaches the top. On that account I think that these effluvia pipes might be done away with. I am very glad to find sanitary matters taking the attention of the public so much.

Professor EVERETT—A great many speakers have expressed the opinion that the open gratings in the streets might with advantage be employed as outlets to ventilate the sewer. The proper plan I think would be not to have air coming in slowly all along the line. Let the air come in at a great distance so that there will be a good rush all along the pipe. We often have to make a compromise between what is best in theory and what is inferior. Some of Mr. Gray's devices would be very good if they were in the hands of sensible and trustworthy people, but I am afraid that some of them, though they would be excellent for skilful and careful hands, are hardly fit to bear the rough usage of ordinary household work.

Mr. J. THOMPSON—If tall chimney ventilators are necessary, the draught in them would be improved by erecting furnaces in which the ashpit material could be consumed by using it as fuel for generating steam, increasing draught, and purifying foul gas as it passes from sewer through fire to chimney. The steam could be disposed of to advantage, while the ashes or slag might be used in making mortar, and a saving would be effected in the removal of ashpit material owing to shorter cartage.

Professor FITZGERALD—I might now call upon Mr. Gray to reply, but there are a couple of points upon which I wish to

say something myself. One of the principal drawbacks with the labouring classes is that, with country people coming in, there is great difficulty in teaching them how to manage town affairs. With reference to an exhibition of sanitary appliances, there is a small display of sanitary appliances in Belfast in the rooms of the Ulster Sanitary Association, and an exhibition on a very much larger scale would very probably, I fancy, answer well. I don't see what damage it could do to the trade. The only damage that could be done would be to an inferior class of tradesmen, whom it might compel to keep better things in stock than some of them are in the habit of doing now. I have pleasure in calling upon Mr. Gray to reply.

Mr. Gray—I confess I am rather pleased with the result of the discussion, which was very much more valuable than the communication I had the opportunity of bringing before you. The speakers referred to so many points that I must take some little time to reply. I agree with Dr. Lindsay that the flush should be a least four gallons. The usual flush gives only two, and is delivered with such a dribble it is useless as a flush. As to Mr. Scott, I cannot compete with him this evening, I am in bad form. The main point he made was the difficulty of educating dirty filthy people. I think I addressed myself to that, and recommended that in our national education schools, our young people should be brought up with cleanly habits. If this is not done, it is impossible to bring up our working class people or servants with any idea as to sanitary matters. If they cannot have proper arrangements in their houses, I think sanitary arrangements in the mansions are of little or no use. Mr. Lockwood referred to an elaborate arrangement of extracting flues. I would rather avoid complications, and endeavour to simplify matters. As to the extraction, I agree with Mr. Thompson, who suggested that the material we are in the habit of removing from the houses is in itself fuel, capable of maintaining a furnace for a considerable time. I was asked if I did away with soil pipe ventilation what would I do with syphonage. This occurs only when the soil pipe is filled with a

very large quantity of water. It is a thing that very rarely occurs. With my plan there would be no danger of syphonage, because the soil pipe remains open. As to the use of wall paper in the closet, I think, if used, it should be made of material impervious to water. Mr. Brown asked what would become of the foul air taken up the soil pipe. I don't believe there would be any taken up when disconnection is properly made. Mr. Winnington has made some very practical remarks under my section B, involving a good deal of business matter which the outside public ought to take care of. He very properly referred to plumbers, and the great improvement that has been made to put them on a proper footing. That is a step in the right direction. All our trades should be registered. The sanitary arrangements of our houses depend as much upon the carpenter as the plumber; but, while I approve of registering tradesmen, I would take care no one was registered as such but a tradesman. Dr. Macaulay made some remarks to the effect that where you make improvements you create disease. I think he will find that it is not the improvement causes the disease, but the process. Professor Everett prejudiced my trap, and said he was afraid that servants would use it badly. A question of education again. It is no argument to do away with an improvement because it would be used badly. We are bound in duty to make it, and insist upon it being kept. If servants do not do it, dismiss them and get those who will. Mr. Lockwood referred to another thing I should have mentioned in my paper, the surface of the workers' houses yards. If you go into some houses and see the condition of the yard you will find it simply covered with everything foul and mischievous. You cannot expect the housekeeper to keep the place nice unless you have all the appointments rendering it capable of being so kept, and when we make our yards on a dead level, with the tiles badly laid, we have them soaking with all sorts of filth. The yards of our workers' houses should not be left level, but have a fall of at least nine inches. I have to thank the audience again for their kind reception of my communication.

5th April, 1892.

PROFESSOR FITZGERALD, B.A., C.E., in the Chair.

ALLAN P. SWAN, Esq., F.L.S., read a Paper on

"MILK AND ITS FERMENTS."

MR. SWAN said:—Perhaps no branch of natural science has of late years made more real progress than that which relates to the biological study of ferments and micro-organisms. The theories on fermentation which were worked out by Pasteur thirty years ago have gradually revolutionised all pre-existing ideas on the subject, and placed the study of ferments on a firm basis, while the ingenious methods of research more recently introduced by Koch are, I think, only second in importance to Pasteur's wonderful discoveries, as they have overcome difficulties of manipulation in the study which were formerly insurmountable. In this paper I only purpose to try to explain some of the natural and apparently spontaneous chemical changes which can occur in milk, and which are always caused by ferments.

We understand fermentation to be a phenomenon indirectly due to the life of micro-organisms, and caused by a special force which is derived from them. These organisms, when present in a liquid which is favourable to their life, grow and multiply rapidly, and their development is generally accompanied by chemical changes in the liquid itself, which changes are due to a disturbance in its constituents, causing them to become rearranged in other combinations. Fermentation may be said to be of two kinds, natural and artificial. When milk turns sour in spite of all we can do to prevent it, the change may be said to be caused by a natural lactic fermentation ; if, on the other hand, we obtain the lactic ferment by collecting a mass of its living organisms, and add them to fresh milk in order to

bring about the change which we generally try to avoid, then the lactic fermentation, which will assuredly result, may be called an artificial one. Thus, a careful study of the life of ferments allows us to apply conditions of control which can thoroughly regulate a so-called artificial fermentation, and we are able to obtain certain products by using the ferment micro-organisms which produced them, the result of such an operation being so certain that its success entirely depends on the skill of the operator. I think that is what is generally understood by fermentation, as the word is applicable to the so-called artificial processes of commerce rather than to the operations of nature, though the result may be much the same in both cases. The micro-organisms of fermentation are generally quite harmless, although in appearance some of them are hardly distinguishable from the formidable microbes of disease. They are one and all true ferments in a biological sense.

It is important to remember that all ferments and moulds have two distinct phases of existence. They live as organisms when they can carry on their active functions as ferments, or they are found as torpid spores or seeds, waiting opportunities of development. In this respect they resemble the more familiar annual plants which at warm periods of the year bear flowers and mature their seed, to wither and die afterwards as the colder periods of the year overtake them, a certain amount of warmth being necessary to favour their life. Many such plants shed their seed, and the winds carry and distribute it. As all ferments require moisture, it is quite impossible for them to exist as living, active organisms in the air. Of course they would be instantly dried up. They are therefore invariably in the condition of dried, torpid spores, which as such not only demand a suitable medium or soil in which to grow, but also some little time before they can germinate. Some ferment spores germinate in a few hours, others require as many days; and this simple difference allows one kind of organism to develop to thousands or millions, before another kind of spore with the same opportunities has been able to awaken to life,

In all of the so-called natural or spontaneous fermentations this fact has a most important bearing. The ferment which is able to develop first and take possession of a liquid, is naturally the one which, by suppressing the others, is able first to exercise its function, and bring about the change called fermentation.

Having dealt with the conditions which control ferments in their development, the lecturer said :—Our next consideration is where the organisms come from, and how they get into the milk. We have every reason to believe that milk as secreted by a healthy animal is quite sterile. Pasteur has shown that other animal secretion fluids are biologically pure ; that is, if they can be collected without contamination from the organisms that float in the air, they will keep without change for an indefinite time. I have satisfied myself that milk can be kept without sterilising ;—in other words, that it contains no ferment spore until exposed to the air, which is full of them. If we consider the comparative food value of fermented against fresh or unfermented milk, it may at once be fairly assumed that the former is far greater, as the difficulty of digestion has already been partially overcome by supplying part of the nutritious properties of the milk in a directly assimilable condition. I have had much experience of the stimulating effect of such food on the yeast plant, and I may add, that in several individual cases of alimentary difficulty, the direct benefit which may result from the use of fermented milk as a food has come under my own observation.

Of late years we have heard a great deal about fermented milk drinks that have been introduced to us from Eastern Europe, and much has been written on their use as an article of diet. A number of foreign observers have from time to time during the last fifty years published books or papers on a Caucasian fermented milk drink called "koumiss," which is prepared from mare's milk, and is recommended by many members of the medical profession in the treatment of wasting lung diseases or alimentary complaints. Genuine "koumiss" is made from mare's milk by the wandering Tartar tribes of the

plains of South-Eastern Russia. "Kephir" is made from cows' or goats' milk by the Tartar people who live on the hills and mountains. Both these fermented milks are strictly articles of diet. "Kephir" especially is for long periods of the year the exclusive diet of the wandering hill tribes, who at high altitudes far away from their settlement have no means of obtaining much other food. The origin and peculiar properties of both these Caucasian milk drinks are solely due to situation and climatic surroundings. It would be impossible to make the same fermented milk even under fairly similar conditions in this country. The best we can do is to imitate as nearly as possible. It is impossible, or at least very difficult, to make a good imitation of koumiss from cow's milk. Any home preparations that I have tested were very different to that made from mare's milk. The ferment organisms of "kephir" consist of a small special type of yeast, and a lactic bacillus which has been named by E. Kern, of Moscow, "Dispora Caucasica;" but I think that in giving it the name Kern has been deceived, like many another investigator of lactic ferments, The number of ferment organisms which develop to bring about these changes in "kephir," or in ordinary buttermilk, might be easily estimated by the nutrient gelatine plate process. I have found them, by actual counting, to amount to nearly 5,000,000 in a single cubic centimetre of the fully fermented milk, which equals about 30,000,000 in the measure of a small teaspoonful, and this calculation certainly underestimates their actual number. In conclusion, I hope you can follow me in recognising our indebtedness to these tiny ferment organisms, as this example only refers to one of the many duties which they are performing, and which were unknown to us until revealed by recent methods of biological research.

The lecture was illustrated by special photographic slides prepared by Mr. Welch and Mr. James Stelfox, and a microscopic demonstration of some of the milk ferments and moulds living in pure conditions of culture.

An interesting exhibition of bacilli and microbes took place,

a large number of microscopes being brought into requisition. The following gentlemen lent instruments :—Messrs. J. Stelfox, James Wright, A. W. Hutton, G. J Glen, Hamilton M'Cleery, W. S. M'Kee, J. J. Andrew, A. Tate, &c. Lamps were lent by Mr. T. Edens Osborne, while the lantern was manipulated by Mr. J. J. Andrews.

Dr. Byers.—I have listened with great pleasure and instruction to the very admirable paper brought before us this evening, a paper which indicated an immense amount of original research and trouble taken in its preparation. Looking at it from a private point of view, and also from the view of a physician, there are two facts in Mr. Swan's paper that seem to me to be of the greatest interest. The first is that milk as it comes from the cow is absolutely germ free, and this applies not only to the cow but also to the human being. The second point brought before us is that, notwithstanding all those numerous organisms that Mr. Swan has shewn on the screen this evening (and which he seems to look upon rather with satisfaction and pride), we have it in our power to destroy them. I am afraid in a certain sense I must join issue with him in regarding these organisms as of advantage. When one looks at the question of infant feeding the chief problem is how to prevent these fermentative changes which Mr. Swan has mentioned as depending on organisms ; in a word, how to render the milk of the cow pure again, after it has gone through the various processes in being brought to where it is used. I may mention as of importance the fact that milk has often an injurious effect if not treated properly. In the first year of infant life there is the greatest mortality, and a notable circumstance is that three-fourths of the deaths during this period of infancy occur in bottle-fed children, children artificially fed, the probability being that this is due to some extent to certain fermentative changes in the milk setting up disease in children, which we are called upon to treat. There have been some recent observations shewing rather curiously that certain forms of food which cause a disturbance in the cow are again attended with disturbance,

especially in children, if milk from the cow is given them; and the most interesting fact is that it does not seem to be due to the milk, but more probably to organisms which pass through the cow and find their way eventually into the milk. As I have said, the two great facts brought out are (1) that the milk is absolutely pure and free from germs as it comes from the animal; and (2) that we have a means, by boiling the milk, of destroying these germs. It is an observation pretty well borne out, that where all the milk in the household is boiled the ordinary infectious diseases are less prevalent.

Professor EVERETT.—I have very much pleasure in supporting Dr. Byers motion. It is always interesting to listen to an original investigator, and Mr. Swan is a gentleman who has made valuable original investigations in connection with microbes. He gave us a most interesting lecture here before on the salmon disease, and now he has laid before us a somewhat similar series of discoveries in connection with the organisms in milk. I remember in the days when I used to read classical authors I came across an account of the Tartars living upon mares' milk, and the account was such as to suggest that they made a fermented liquor from it. We have had some account of that in the "Koumiss" and "Kephir." I was a little startled at Mr. Swan's statement that he hoped we understood from his lecture that these organisms were beneficial. Like Dr. Byers, I don't quite see it myself: and I hope Mr. Swan will make this a little clearer in his reply. Talking about the strength of the Koumiss reminded me of a case I read a week ago in the newspaper where an inspector had summoned a milk dealer for watering milk, but although one would expect that the watering would make it weaker, the inspector had to tell the magistrate that the bottle had exploded, and he had to withdraw the charge. I have nothing more to say, except to ask you to include in the vote of thanks the name of Mr. Andrews, who has kindly manipulated the lantern.

Mr. CONWAY SCOTT—I have been greatly pleased this evening with the lecture which Mr. Swan has given us; but I

think on the whole it is an alarming state of things to find that you have thirty millions of living creatures in every spoonful of buttermilk, and it would be very desirable if Mr. Swan could assure us that these animals were perfectly harmless. One thing we must be glad at, that he has cleared the character of the cow. My own experience in regard to typhoid fever is invariably that when you trace it to the milk it is not the cow, it is the careless or filthy human beings that are the root of all the evil.

Professor FitzGerald—I think Dr. Byers's remarks of special value in this, that it is important, when matters of this kind are brought forward, that those who are not acquainted with the practical bearing of such investigations should be impressed with the fact that these things can at once be seen by those who, like Dr. Byers, understand them. I understand from Mr. Swan, however, that though the milk as it comes from the cow may be free from organisms, yet it is practically impossible to collect it free from organisms ; and that is the reason why it is absolutely necessary to destroy them afterwards in the way Dr. Byers spoke of. Mr. Scott's remarks were very much to the point as to the real persons who are to blame for infection being carried by milk. My impression is that it would be a very desirable thing if medical men had the power to close a dairy for a time where they suspected such a thing.

Mr. Swan—It was not my intention to give you any idea that ferments could be as dangerous as the microbes of disease. I hold that ferments are essentially those organisms to which we are under an obligation for doing actual good. It is extremely difficult to separate milk from organisms, except in a laboratory ; the moment it is exposed it becomes contaminated with them. I chose the subject of milk ferments this evening, as it is one in which I perhaps have had exceptional opportunities of observation, having lived in those countries where the fermented milk drinks are made. I should be very sorry to raise an alarm on the subject of microbes, but if you separate ferment organisms from disease organisms this will not be likely. I am thankful

to you for the very patient hearing you have given to me this evening, and am indebted to Mr. Stelfox and Mr. Welch for the great assistance they have given me in making the micro-photographic illustrations you have seen. I have also to thank Mr. Andrews for the very kind way in which he has officiated at the lantern.

The President announced the following donations :—A number of South African bird skins, presented by Mr. George Gordon, Cambridge Villa, Strandtown ; and hawks, owls, and a form of weasel, presented by Dr. Singleton Darling, Lurgan.

On the motion of Mr. R. L. Patterson, J.P., F.L.S., seconded by Mr. Joseph Wright, F.G.S., a vote of thanks was accorded to the donors.

The proceedings then terminated.

23rd December, 1891.

ENGINEERING SECTION.

Inaugural Address by the President, WALTER H. WILSON, Esq.,

RECENT ADVANCES IN MECHANICAL SCIENCE.

MR. WILSON said:—It has been, I think wisely, considered advisable to make a special section, in connection with the Natural History and Philosophical Society, for Engineering, which, I understand, will include both civil and mechanical engineering. Many years ago, I should say from 25 to 30, there was an Engineering Society started in Belfast. The number of members was not large, and they were all young men. We had a room in Castle Place, and regular meetings. Mr. Macassey, of Waterworks celebrity, was one of its leading members. I think its collapse was partly due to the fact that we were all rather young, and that older men then in the various branches of the profession and business in Belfast rather looked down on our efforts. We had papers and discussions, some very animated ones, but it came to an untimely end. At the present time, however, things are somewhat different, and I see every hope of such a Society prospering, forming as it does a part of the Natural History and Philosophical Society. It is a great pleasure to me to think that there have been some 70 names already put down of those who are willing to join. I would dearly hope that we may find that the ranks of the section may be much recruited from the members of the staff, and the pupils or apprentices at present engaged in the various establishments connected with the engineering professions in the city.

The chief characteristic of more recent times as affecting engineering work is the development of commerce and all that this means, but I will content myself with commenting only on

one branch of this subject, being that which seems to me most suitable to draw your attention to this evening. Practically, until the beginning of this century little had been done to utilize the great resources of nature, and the development of the services they can be made to render to man has only been followed up within the last 50 years or so.

In the present assembly, I think I may safely put mechanical achievements in the first place ; next come electrical, and in the third place chemical discoveries, which are worked in, one with the other, to bring about the development of those results which we daily hear of and see.

To sub-divide my subject into some of its branches, we may begin with the development of our present gigantic railway system—its construction and working—from the first short cast-iron rails, with horse-drawn cars or waggons, jolting along without springs, at a few miles an hour, to the long mild steel rails, palace cars, and tubulous trucks drawn smoothly along by a compound locomotive at a speed, in some cases, of about a mile a minute : where the traveller can repose in a comfortable berth, almost as if he were at home, while the train he is conveyed by hurries him all through the black night over hill and dale, through the long tunnel, and over the high bridge, without his being even conscious of any risk. Should the mechanical skill which has apportioned and proportioned the various appliances and parts to their duty have made an error of judgment, and some apparently trifling detail be overlooked or forgotten, or some law of nature be disregarded in carrying out the construction or working, what would be the result ? I may say, what has been the result in some cases ? Crash, collapse, cries of agony, and the stillness of death when it is all over ; and yet, as a rule, it is found that the cause of most so-called accidents is an an attempt to violate some trifling, it may be, but inexorable law of nature, or some carelessness in not having sufficiently considered these laws of nature. This is only one of the difficulties the engineer has to cope with, and no wonder it is an interesting and engrossing profession and business. Let me

follow the consideration of what the Americans call the "track" for a few minutes, and what is involved by the construction of the track.

In the early days of railways, engineers were content to select a nice level piece of country with very few hills and as few rivers in the way as possible—in fact, the choice of which towns were to have the honour of being connected by railways was arrived at by the character of the intervening ground—but nowadays no difficulty, not even the Belfast under-strata of mud, nor warning accident, seems to stop the skill and determination with which each new project is set about, and generally succcessfully completed ; and, what is quite as wonderful, the public shew the confidence they have in the members of the engineering profession by providing the money, without which the vast works proposed could not be carried out. Many people have no conception of what the difficulties were, in an engineering way, of piercing a tunnel such as the one through Mont Cenis. The work was begun at each side of this great mountain, at two spots about 9½ miles apart. The shaft pierced was not level, but rose towards the centre of the mountain from each side for drainage purposes, and could not be carried in a direct line owing to geological difficulties ; yet the two holes met each other accurately in the middle of this mountain, a feat acknowledged to be a triumph of human accuracy and skill.

To bring the feat more within the grasp of our minds, we will suppose the tunnel to be only the size of a mouse-hole, say about $\frac{7}{8}$ of an inch in diameter, and there are two mice who want to have a short cut between their houses through a big mound, to save their having to go over the hill. Then each mouse would have to burrow a hole 100 feet long. If they met, the total length of the hole would be 200 feet. If this hole were dead straight, the difficulties to be conquered would be great enough, but on account of the angle both in plan and elevation, the difficulties of meeting each other in the centre of the mountain are vastly increased.

I might multiply examples of curious and cleverly tackled

difficulties in connection with tunnels, such as the Severn tunnel, both in their design and construction; but there are other structures which to my mind are much more interesting, which should at any rate be touched upon. A tunnel can have no grace about its design. You would say anybody that can dig and build could make a decent tunnel. It becomes a different matter when you expose your work to the light of day. Strange as it may appear, the sunlight, or rather the heat which accompanies the light, is a most troublesome matter to deal with in iron or steel bridges, from the effects of the expansion and contraction of the structure. Then, there are the effects of wind and weather, and the critical eye of the profession, and of the even more critical public, to contend against, all of which the tunnel constructor need not trouble himself about.

To go into even a small outline of the history of the principal types and designs of bridges—tubular, suspension, girder, cantelever, and others—would be impossible in the time at my disposal, but a most satisfactory evening or two might, and probably will, be spent in the consideration of such structures, and how and where the different designs were started. The great cantelever across the Firth of Forth is a developed form of a rude bridge of this type, of one span, built across a small river in China, designed many years ago, to overcome a difficulty where the river was too wide for the construction of a single span with the available materials. The history of how the various types of suspension bridge developed is particularly interesting, culminating in the Brooklyn Bridge, which I think is the last big bridge of that type we, or even the Americans, shall see built. Most interesting also have been the illustrations and descriptions of the various stages of construction of the Forth Bridge which have appeared from time to time in the engineering journals. This structure is simply gigantic, and dwarfs the Eiffel and the proposed Chicago towers into nothing. Even a child can build up bricks one on the top of the other to a considerable height, but it becomes a different story when such a structure has to be built out horizontally under the open firmament of heaven from

two sides, and then a big piece to fill up the gap has to be dropped in between the supporting arms, and the whole structure made equal to carrying its own weight as well as that of passing trains, and bearing the force of the winds, changes of temperature, &c.

The possibility of making such structures is, I may say, an immediate result of the new modes of manufacture lately invented for producing the material called " mild steel." The possession of this material has enabled the engineer to achieve results otherwise impossible. It would almost seem as if there was no limit to the size, thickness, and weight of plates which can now be produced by the steel makers. I well remember the time when the size of plate available from iron manufacturers without paying extra was 6 feet long and 2½ feet broad. Any plate over 4 cwt. was charged for at a higher rate. It was thought to have been a great step in advance when it was possible to obtain plates 9 feet by 3. At the present time plates up to 30 feet long and 5 feet wide are constantly used in the construction of ships. I may mention that we have had plates delivered nearly 4 tons weight and 7 feet broad, and we have also had plates no less than 38 feet long and 3 feet wide for ship work ; and in the manufacture of boilers it is a common thing to find plates dealt with of over 4 tons weight. We have had many delivered 4½ without extra since having to be paid. Rolls for making such plates have now been fitted by Messrs. Spencer, of Newcastle, whieh are 11 feet wide ; in other words, they will be able to produce and finish a plate about 10 feet wide and probably between 30 and 40 feet long, so that we can now obtain plates whose area is twenty times what, within my recollection, it used to be possible to produce.

What a change has come over the rolling stock, as it is called, during these comparatively few years, from the " Rocket " and " Puffing Billy " type to such a locomotive as has just been completed and put to work by my friend Mr. Webb, of Crewe, called the " Greater Britain." The average speed at which this locomotive drew a train, the gross weight of which was 382

tons, between Rugby and Euston, was nearly 45 miles an hour, and a maximum speed of over 55 miles an hour was obtained, and this with a consumption of only 1,500 lbs. of coal per hour; a result not before achieved, I believe, anywhere. This engine with its tender weighs no less than 77 tons. I may refer also to the changes and improvements in rolling stock, the palace and drawing room cars, and all the other ingenious and convenient appliances which have been added to the railway system in our recollection ; nor should I omit to mention the development of the great and wonderful system of signalling which makes the running of such trains safe—this in itself is a study ; or the brake system, with all its failures and successes, which has been so much developed, and which enables a train to be brought to a standstill in so short a distance as to avoid many otherwise inevitable accidents.

I cannot pass on without a few remarks on cable tramways, which have been brought to such perfection in America. There is a great future before this system of passenger transport, and much ingenuity has been expended and many lessons learnt in the development of these at San Francisco, Chicago, and elsewhere ; while the returns on capital invested in these cable tramways are most encouraging ; so that we may expect to see before long in place of our tram cars, drawn at 4 or 5 miles an hour by miserable horses overstrained every time they start the heavily-laden, cumbrous machines, a vehicle drawn without horses, which can average 10 miles an hour, and can be stopped and started with ease. At the present moment there are no less than 75 such cable roads in existence, working 700 miles of track, with 3,500 trains of cars worked at a speed of from 6 to 14 miles an hour, and driven by engines of 50,000 H.P. I cannot do better than quote from the report of the committee on the progress of cable motive power just issued :—

"Financially, the cable road shows a low operating cost, less depreciation, and a higher earning capacity than horse traffic.

"Practically, it ranks foremost in trustworthiness and independence of climatic conditions, moving its load through heat, cold, snow, frost, or flood with regularity and certainty.

"Socially, districts can be worked by it when there are steep grades when horse haulage would be useless or impossible, larger, better, and more numerous cars can be used, and the noise of working is much reduced."

There are other advantages which I need not enumerate. Should electricity come to the fore, as there is every possibility of its doing, even the cable tramway may have to "hide its head."

I think the railway system and the thoughts connected with it have now taken up a good share of my time, so that we had better proceed to the consideration of another great branch of commercial mechanics, I mean the navigation of the waterways of the world, seas and canals. After all, ships are really only floating bridges, and some ships may be described as floating palaces as well.

The changes in sizes, proportions, and so on in these structures have of late years been so rapid and drastic that reliable information with regard to them is not to be obtained from books, the fact being that everybody who is in a position to be an authority on the subject has his head and hands full of work in carrying out these changes and improvements.

We have in this port at the present a very large cross-Atlantic steamer which only eight years ago was constructed by one of the Clyde shipbuilding and engineering firms. Her last visit to this port was on her trial trip, which was celebrated by the eating of lunches, and the popping of corks, and so on. Well, now she has come to have her boilers removed and her machinery altered. She could no longer compete in the work, and her owners must lose the use of her for six months or so while this is being done. On the other hand, we know of vessels 17 or 18 years old which are doing as good work as ever, if not better, with their old engines and boilers—favourite ships with passengers. What a tale this tells both of good design in the first instance, careful and conscientious construction in the second, and good upkeep during all these years in the third.

The designing of ships belongs, I think, more particularly to what is actually looked upon as the civil engineering branch of

the profession, seeing that the structure has to be one fit to contend with all the duties a railway bridge has to perform as a girder, with this tremendous difference, that the railway girder may be, and often is, made ten times the weight of the load it carries, while a ship has to contend with the waves—no unimportant addition to the strains brought to bear on the structure common to both constructions. She has also to carry her engines, boilers, coal, stores, and water, and the gross weight of all these and the material used in her structure is only about one-third of the weight she carries, *i.e.*, her displacement. Also, in the construction of ships and their fittings the work of an architect comes into play, not only in giving character to the external appearance of the structure, but in all the details which constitute the comfort of home life, giving comfortable accommodation to man and beast night and day, with warmth and ventilation under difficult circumstances; while many other difficulties which surround ship construction are not necessary to be considered in structures on land, and are all the more difficult to design and arrange for, owing to the necessarily restricted space available.

From an engineering point of view, therefore, a vessel, besides being a girder, has to be designed to carry an enormous amount of power, in many cases more than one-horse power per ton of the gross tonnage of the vessel, and the exercise of this must not unduly make a vibration in the structure. On this subject much could be said. Theory has had to follow practice in this as in many other things. To deal with the peculiarities of vessels which have only manifested themselves by experiments with different forms and areas of propellers, different pitches and speeds of screws, would fill up an evening by itself.

Few people think, even those who are daily conversant with the construction of mills, what the differences of the conditions of working are; say of the engines in some of our big local mills, and at sea. Probably there is not one of these where over 2,000 indicated H.P. are used. In steamers six to eight times this amount is not at all unusual. These mill engines are run

about $9\frac{1}{2}$ hours a day, with two intervals of stoppage, breakfast time and dinner time, and they are not called upon to work on Sunday, so they have a fairly good time to put matters to right when needed. Even across the Atlantic the engines running full power for from six to ten days without stopping once is a severe trial, but it is nothing to the runs made out to Australia and New Zealand, when the engines of steamers have run for 1,200 consecutive hours (which corresponds to about half a year's work of a land engine working under very much easier conditions), and have made 16,000,000 revolutions, and driven the vessel 41,000 knots, without an overhaul, and at the end of this nothing had to be done. I have known of small engines for driving electric lighting appliances which have run for four months night and day, Sundays and Saturdays, without once being stopped. Where have you such a record on land ?

Now, with regard to the foundations of such mill engines as I have described, any amount of weight is available, and is used to give the machinery a steady base to work off, and immense masses of masonry and castings are used ; but on board ship nothing of the sort is possible, the weight of the machinery and all its connections must be carried on the structure of the vessel, and it must be so arranged that the engines and boilers can be tumbled about in all directions without cessation often for days together. At the same time all must go on working up to full power. There is no saying "keep her going until the meal hour and then we will fix her up." If the engines have to be stopped in a steamer every passenger, male and female, is on the *qui vive.* "What is wrong?" "Is there any danger?" "Shall we get run into while we are stopped?" and so on, and on arrival in port the newspaper interviewer comes on board, and, may be, gets a hold, we will say, of some admiralty official who has happened to be a passenger, and gives a graphic account of the dangers he and his fellow passengers have come through owing to the stoppage of the main engines, which probably has only been necessitated by a warm slide or rod, or a joint in a pipe giving out, or a loose bolt, or some other trifle

which could not have been put to right without a stoppage, and which there were no regular stoppages to correct. What would a passenger across the Atlantic say if it was usual to stop for an hour twice a day and for all the night, so as to make small defects right?

For a locomotive, two or three hours is considered a good run without a stoppage. I have often come through experiences of this kind afloat which got into the papers, but which if they occured on shore would pass without comment. It is a curious thing how slow the owners of land engines have been to follow up the lead given them by marine engine builders. It is only within the last year that they have been induced to take a leaf out of the new book; two local firms having become alive to the state of the case, and, no doubt, others will follow. It has to be borne in mind that every pound of coal and every ton of engines, boilers, and water carried restricts the carrying power of a ship, which means, of course, the earning power of the vessel. Every ounce of weight wasted in the supports of the machinery, &c., acts in the same way. A land engineer can put hundreds or thousands of tons of foundations down to carry his machinery, and he can get his coals, like Dr. Chalmers, in by the bag, or he can lay his winter's stock of fuel *in on the cheap* in the most favourable season, it does not seem to touch his profits disadvantageously one way or another, and yet he does not seem to see what an advantage it would be for him to have engines which would work for half the coal and need comparatively no repairs. The secret is, that it would cost him a little more in the first instance to make the installation. I hope to see a great change in this respect, when the land engineer realises what his brother, the marine engineer, has done. A great deal might be said in following up such a subject as this.

In connection with mechanical subjects, which all more or less depend on our supply of coal, we are no doubt all aware that out of the possible value to be obtained from a given quantity of coal, even with the most perfect appliance for

converting it into power, we can only obtain a very small per centage usefully (only from ten to twelve per cent). A little anecdote, to illustrate the value of coal, may not be out of place here. Some of those present may have heard it, but it will bear repetition for the sake of those who have not done so.—I was travelling down some time ago from Dublin to Belfast in a compartment of the train occupied by four gentlemen, evidently from their conversation connected with, and interested in, railway work. Among other subjects, they were comparing the relative cost of fuel on several lines of railway, and they made out that in an ordinary freight train a ton of cargo was carried for twenty-five miles at a speed of fifteen miles an hour for one pennyworth of coal. I happened to have the data of carrying power, coal consumption, and speed of some large cargo vessels, and I worked out the corresponding facts for the results which had been obtained afloat. I was somewhat astonished with the figures obtained, but they were quite correct. It was simply a new way of looking at it, and it gave me a respect for coal which I had not before possessed, and which it would be well if this nation would realise before it allows our coal fields to be emptied into foreign countries with no national gain to us, very little gain for the coal proprietors, and only benefiting the colliers, who consume the best part of their earnings in intoxicating liquors.

Taking such a vessel, I found her results to be :—average sea speed, 15 miles ; coal carried, 6,500 tons; consumption, 51 tons per 24 hours. This works out (at 13/- per ton for coal, which is about the cost of coal when put on board ship in, say Liverpool) that one ton of cargo is conveyed no less than 294 miles for one penny worth of coal.

Ship.	D.W. in tons.	Coal per day.	Speed.	Miles.	One ton of cargo carried for 1d.	
					Coal at 12/- per ton.	At 13/- per ton.
			Knots.	per hour.	Miles.	Miles.
Imaum, ...	6420	36 tons	$11\frac{1}{2}$	13·24	391	365
Gaekwar, ...	6575	27 „	$10\frac{1}{2}$	12·0	486	448
Alex. Elder,	6510	33 „	11	12·6	410	378
X, ...	6500	51 „	13	15	318	294

This is no doubt very good. But I may point out that it is not by any means usual or economical to carry coal at so high a speed as 15 miles an hour at sea. To illustrate this, a pennyworth of coal will carry a ton at $13\frac{1}{4}$ miles an hour no less than 365 miles, or at $12\frac{1}{2}$ miles an hour about 390 miles. In the "Gaekwar," which we built about a year and three-quarters ago, and which is, I imagine, about as economical a ship as can be found afloat, a pennyworth of coal has absolutely carried a ton 448 miles at a speed of 12 miles an hour—*i.e.*, she has carried 6,575 tons of dead weight of coal at a speed of $10\frac{1}{2}$ knots (=12 miles an hour) on a consumption of 27 tons of coal per day of 24 hours, and this steamer has been regularly doing this between Liverpool and Calcutta.

Well, to return to my story, I joined in the conversation with these railway gentlemen, and got them to guess what distance a ton could be carried afloat at 15 miles an hour for onepenny worth of coal. One, after some consideration, thought, all things considered, that it might be a longer distance than the train could carry it, probably 40 miles; the others made various guesses up to 80 miles. They would hardly believe me when I told them the fact. You will agree with me that it is an astonishing way of looking at it.

These few remarks on the subject of coal naturally lead to the consideration of the appliances in which the coal is burnt and steam is raised. Probably no subject in connection with engineering has given more scope or variety in design than boilers. I remember seeing many years ago vessels fitted and worked with copper boilers, simply arranged with a furnace and a return flue to the chimney, worked at a maximum pressure of 6lbs. on the square inch; while now there are two vessels of our own build at sea (the "Philadelphian" and the "Lancastrian") working across the Atlantic with 200 lbs. boiler pressure upon the square inch, giving most satisfactory results. Probably no type of boiler gives a better result than that at present in use in the mercantile marine. Designers seem to have had to settle down to this type after having pursued others through

many phases. We had hoped at one time that a great future was before a tubulous system of boiler, patented by the late Mr. Perkins, where pressures up to 500 lbs. on the square inch were carried, but before advising our friends to adopt this type we fitted a complete engine and boiler indicating over 200 horsepower in an old steamer, which worked fairly well for some years, but eventually the whole plant had to be condemned for a variety of reasons which at the present time I cannot detail. Probably no boiler of this type is more satisfactory than the design carried out by Messrs. Thornycroft for their torpedo boats, but I have my doubts whether this style of boiler will come into use for mercantile marine work.

Great misapprehensions exist in the minds of many people regarding the danger of working at high pressures, but their fears are entirely unfounded. No structure, so far as the strain brought to bear upon it is concerned, is better treated than a boiler. Steam is got up very gradually, is kept up steadily, and is again lowered very slowly. The only evils that are troublesome to deal with arise from expansion and contraction due to differences of temperature in various parts of the boiler, and, in former times especially, pitting of the internal surface of the boilers. This has been discovered to originate from air in the water, and has latterly been practically got rid of.

But it is time for me to go to another branch of the subject. I have mentioned electrical results. In a way, these dwarf all I have outlined in the purely mechanical line. It is when the two branches—electrical and mechanical—come together that the feature of the coming age is made manifest. We are only on the verge of what is before us from the result of the union of these two sciences, especially when they are associated with chemistry. Much has already been done by such men as Siemens, Sir Wm. Thomson, and a hundred more clever scientists in our own country to bring electricity to the front, but all these discoveries and results obtained, however valuable, are put in the shade by the wizard of Menlo Park—Edison. He is by far the most prolific inventor of the age in that line.

Our own scientific men are not hopeless by any means, if we are to judge of the future as spread out before us at the meeting of electrical engineers in London last month by Mr. Wm. Crookes of radiometer celebrity, whose remarks are well worth reading ; but Mr. Crookes certainly seems to me going a long way when he announces "that in a single cubic foot of ether, which fills all space, there are locked up 10,000 foot tons of energy which has hitherto escaped all notice." If Mr. Crookes can unlock this store and subdue it to the service of man, the coming generation has not a bad programme before it. "Live and learn ;" "Patience and perseverance" are a good pair of mottoes for the engineer. There is little that cannot be conquered by the the exercise of these three latter qualities so long as we have that first necessary, life.

I must now draw my remarks, which have necessarily been of a most glancing and superficial character, to a close, with the hope that this new branch of our Society may be well supported, especially by the younger members of the engineering flock in our city.

th March, 1892.

JOHN H. MACILWAINE, read a Paper on

THE TONNAGE OF SHIPS.

MR. MACILWAINE said—The word "Tonnage," as applied to ships, originally meant an estimate or measure of the ship's carrying capacity.

The term "Tons Burthen" is probably the oldest expression for what we now call "Tonnage." It was used to mean an estimate of either the dead-weight carried or the internal capacity of the ship ; and in the type of vessel in use at the beginning of this century it generally approximated to both, calculating the internal capacity at 42 cubic feet to the ton.

This term "Tons Burthen," and also the word "Tonnage," are supposed to be derived from the French custom of estimating the rating of a ship from the number of tuns of wine she could stow and carry, reckoning four casks to the tun.

Now, the word "Tonnage" has two separate, and generally very different, meanings.

First, it may be used to express the real capacity of the ship for carrying cargo ; this I would call the "Actual Tonnage," and it pretty fairly represents the earning power of the vessel.

Second, the term "Tonnage" may be used to express the "Nominal Tonnage" on which a vessel pays dues, now called the "Nett Register Tonnage."

The actual tonnage is obviously the most important from an owner's point of view, and also most interesting to the naval architect, for on it the amount of freight earned will chiefly depend ; still, nett register tonnage is in some cases an equally important element in the earning power of a vessel.

It is so obvious as to be hardly worth mentioning, that in all

trades, to a certain extent, the difference between what I have called the "Actual Tonnage" and the "Nominal Tonnage" must be an important matter to the shipowner. This difference in the home trades, and especially in short channel voyages, where a vessel may be paying dues every day, becomes a matter of the greatest importance. Hence it came that the owners of steamers trading in the channel began to feel the advantage of a low nett register, combined with a large carrying capacity; and builders gave their attention to designing vessels that would fulfil this requirement.

It was found possible, under the present system of measurement, to produce dead-weight carrying vessels, whose nett tonnage was only a fraction of what it should fairly have been, while passenger steamers were designed and built with less than no nett register tonnage.

The amount of this nett register tonnage is determined by an Act of Parliament administered by the Board of Trade, and this Act decides on what basis a vessel should be taxed for services rendered by various bodies, such as the owners of harbours, and corporations who provide lighthouses and other facilities for navigation. The most important effect of assigning a tonnage, is the determining how much each particular vessel shall pay for such services rendered.

These receivers of dues have always tried to influence legislation, so that every vessel entering their harbours or deriving advantage from their lighthouses, &c., shall pay at least a fair share of dues levied for the construction and maintenance of such harbours and lighthouses. On the other hand, the shipowner is naturally anxious that his particular vessel shall pay as little as possible; and shipowners, on their part, have always tried to prevent legislation from unduly taxing any class of vessel in which they, as individuals, are interested.

We have thus two conflicting interests whose representatives use every effort to further their particular views; and in each fresh attempt to legislate for tonnage, there has been an effort made to hold the balance fairly between these rival claims.

The question I propose to discuss is: Does the tonnage law as it stands at present give a reasonably fair basis for taxation, or can a better be offered? In other words; Does the internal capacity, with additions and deductions as last settled by the Act of 1889, give a fair basis for taxation, or could we substitute a better?

To understand how the matter rests at present, let us glance briefly at the history of the tonnage laws, for say, the present century.

During all this century the nominal tonnage, or register tonnage as it is called, has been based on a vessel's supposed carrying capacity. Two systems have been in practice for estimating this.

At the beginning of the century, and up to 1836, the rule for determining the registered tonnage of a ship, now called "Old Builder's Measurement," was in force; it was an attempt to approximate the carrying capacity, and the rule for obtaining it was as follows:—From the length substract $\frac{3}{5}$th of the beam multiply by the beam and half the beam, and divide the product by 94.

I have never seen any explanation offered as to the principle on which this rule was based, but it seems to assume that the average depth was about half the beam of any particular vessel; and that a cube obtained by multiplying together a certain proportion of the length, the breadth, and the assumed depth, and dividing this by 94 would give a fair approximation of the older "Tons burthen" reckoned at 42 cubic feet to the tons stowed.

It is called old builder's measure because it was superseded by the Shipping Act of 1836; but it was used long after that date by builders, as a basis on which new vessels were contracted for.

No doubt this rule answered very well for the type of vessel then in existence, but it soon occurred to owners and builders that an unduly small register tonnage in proportion to cargo carried could be obtained by altering the proportions, and

building ships abnormally deep, giving them at the same time less beam ; thus producing vessels that were crank, slow, unhandy, and with an unnecessarily deep draught of water.

In 1836 a Merchant Shipping Act was passed, and in it a new system of tonnage measurement was included, which system, perfected by the Act of 1854, remains the basis of tonnage measurement to the present day.

The main feature of this system is, that the actual internal capacity under deck is first calculated by a fairly accurate method ; additions are made for the covered in spaces above deck in which cargo might be carried ; the sum of these is called the "Gross Register Tonnage." When the gross tonnage has been ascertained, deductions are made for spaces, either above or below deck, set apart for the berthing of the crew in all vessels, and for the spaces occupied by machinery in steamers. The result, after making these deductions, is called the "Nett Register Tonnage," and on this nett register nearly all dues are paid.

This mode of measurement was an immense step in advance, and in my opinion was a great improvement on any previous attempt to establish a fair basis on which to levy dues. Whether the time has come for a further modification of it, or a complete change in tonnage measurement, is a question we may fairly discuss to night.

The question of the allowance for propelling power was the most difficult the passers of the Act of 1854 had to deal with, and as this portion of the Act has led to most of the trouble in administering the law, and to most of the anomalies that existed and have been only partially remedied from time to time, I must refer to it more in detail.

It was obviously necessary, to conform with the principle on which the tonnage clauses of the Act were based, that if steamers were to compete with sailing vessels, some allowance must be made for those spaces occupied by engines and boilers which were of course not available for carrying cargo. It was easy to measure such machinery spaces, as they were called, but

that was not enough ; it was also thought necessary to make a further allowance for the spaces in which coal should be carried. For this two alternative plans were provided.

First, if the space occupied by machinery in a paddle steamer is between 20 per cent. and 30 per cent. of the gross register tonnage, the allowance shall be 37 per cent. of such gross tonnage. In the case of screw steamers, if the space occupied by machinery is between 13 per cent. and 20 per cent. of the gross tonnage, the allowance shall be 32 per cent. of such gross tonnage. Or secondly, at the option of the owner, the allowance shall be in paddle steamers one and a half times, and in screw steamers one and three-quarter times the actual space occupied by the machinery.

There was a curious flaw in the Act of 1854, by which it was possible to include in the allowance for machinery space certain spaces above deck not included in the gross tonnage, and by this means a great number of vessels were reduced to an absurdly low nett register tonnage. This defect was remedied by the Act of 1889, so that it is not necessary to discuss it now.

Since the passing of the Act of 1854, several Royal Commissions have sat, and Acts of Parliament have been passed making sundry changes. It would be interesting and instructive to trace the history of these changes and assign causes for them, but time would not permit.

In the case of steamers, we may look upon the law as it at present stands, that is to say as amended by the Act of 1889, as the result of over 50 years' experience of the principle of taking internal cubic capacity as a basis for nett register tonnage; and yet vessels measured under its provisions present so many startling anomalies as to make out a *prima facie* case for a complete change in the present system of measurement. It is needless to prove this, as a reference to Lloyd's Register will show innumerable cases where vessels contribute dues not in proportion to their size and presumable earning power, and certainly out of all proportion to the services rendered. The reason for this disparity between services rendered and taxes

received arises almost entirely from deductions for propelling power in steamers, and I do not see how this is to be dealt with fairly, so long as internal cubic capacity is the basis of taxation. Another cause of this disparity is the treatment of closed in, and partially closed in, spaces above deck, also in my opinion a subject almost impossible to deal with fairly so long as internal cubic capacity is the basis for tonnage. Another great objection to the present system, is that it leads to building vessels specially designed to evade the tonnage measurement, and handicaps a designer who wishes to make the best vessel for her intended trade. It is comparatively easy to condemn any existing system of taxation, but a much more difficult task to propose a better.

Many alternative systems of measuring taxable tonnage have been proposed. Among others, are these :—To tax length alone ; length and depth, or length, breadth, and depth ; to tax the volume of displacement between light and load water-line ; or last, to take the actual displacement of each ship as a basis for assigning a taxable tonnage. Displacement is adopted in the Royal Navy as a means of comparison, and is often used now-a-days in comparing modern merchant steamers. In my opinion, the essential points to be borne in mind in discussing any new system of tonnage are :—

First, that the nett register or taxable tonnage shall be so assigned that each vessel shall bear a fair and, if possible, a proportional share of dues for services rendered by the receivers of these dues.

Second, that the dues levied shall be on a basis most likely to bear a fair proportion to the earning power of each vessel.

Third, that there shall be no serious disturbance of the existing nett tonnage of those vessels which are fairly rated in proportion to their earning power.

Keeping these essential points in view, there are three of the many alternative plans proposed which are worthy of consideration.

First, we may continue to take space available for cargo, &c,

as a basis of taxation; further amend the present law as occasion arises; and as soon as a new and unduly favoured type of vessel appears, pass an Act to provide specially for that type; or the powers of the Board of Trade may be extended, giving them fuller authority to deal with tonnage measurement.

There are serious objections to both of these proposals. As to the first—further legislation on the present basis—history tells us that the most glaring anomalies may exist for years, and the calculations of all bodies depending on shipping dues may be completely upset and put in confusion before the law can be amended: and no sooner is one anomaly stamped out, than the ingenuity of owners and builders is at work to produce a new type of vessel to evade the amended law. With regard to the second suggestion—increased powers to the Board of Trade—I don't think past experience would induce us to favour that alternative.

Another proposal is to tax all vessels in proportion to the product of their principal dimensions under water, viz:—length, breadth, and draft of water. There is one serious, I may almost say fatal, objection to this method, viz:—That it would encourage the building of, and really set a premium on, abnormally full ships; in fact, under such a law the more like a box a vessel was built, the greater would be her dead-weight capacity compared to her nett register tonnage.

The third plan, and I think the best, is to tax all vessels in some proportion to their displacement, in this way:—Let the shipowner fix his maximum draft of water—in other words, his freeboard—and let some percentage of this displacement be the nett register tonnage of his ship. This percentage of the total volume of displacement should be different for steamers and sailing vessels, and should vary with the size of the vessel.

Displacement, as a basis for taxation, seems to me to fulfil, more nearly than any other, what I consider the three most essential requirements of a fair tonnage measurement.

First, as to the dues being in proportion to the services rendered by harbour authorities and others, it is obviously just,

because harbours are called upon to accommodate the outsides of vessels, not a limited portion of their internal capacity as paid for at present; and displacement bears a direct proportion to the outsides of all vessels.

As regards the second point, viz:—That taxation should be as nearly as possible in proportion to the relative earning power of various ships, I think we have in displacement the most generally applicable basis for comparing all classes of vessels.

The third point I consider essential in any new departure is, that there should be no serious disturbance of the present nett tonnage of such ships as are now fairly rated. This is a more difficult point to deal with, but still I think displacement as a basis offers a fair means of attaining this end.

In proposing, for taxation, displacement instead of internal capacity as at present, we are changing the basis of comparison, taking weight instead of measurement; hence we must have a new standard. I propose to take the average weight-carrying vessel, determine what percentage of her displacement is taxed now, and adopt that as a fair basis for all vessels.

The percentage of displacement I propose to vary for steamers and sailing vessels, increasing this percentage as the size of the vessel increases.

From working out a number of examples, I have come to the conclusion that for steamers with a displacement of 500 tons, 20 per cent. of this displacement would be a fair nett register tonnage; for 1,000 tons 21 per cent.; and for each additional 500 tons I would add 1 per cent.; that is to say, 1,500 tons should be 22 per cent., 2,000 tons 23 per cent., and so on in proportion, so that for 5,000 tons we would have 29 per cent., and for 10,000 tons 38 per cent.

In the case of sailing vessels, I propose to increase the percentage taken for steamers by 10 per cent.; that is to say, take 30 per cent. for 500 tons displacement, 31 per cent. for 1,000 tons, and so on.

With regard to passenger and cattle steamers, I think it would be found that the same percentage as that applied to cargo steamers would give very fair results.

I do not say that the percentages indicated above are the best, but I merely put them forward as approximations, to be altered if necessary.

I think it will be found that where there is a great difference, in any particular vessel, between the proposed percentage of displacement and her present nett register tonnage, that there is something peculiar in the design of this vessel; that my displacement tonnage more nearly represents her probable earning power, and that the dues under the amended tonnage are much more in accordance with services rendered.

The foregoing is necessarily a mere outline of the principle of taking displacement as a basis for assigning nett register tonnage. In addition to the reasons for preferring it as given above, it has the following advantages:—

It would encourage owners to give their vessels more freeboard, and further to increase the safety of their ships by adding closed in spaces above deck, because in neither case would they be liable to the penalty of a higher nett register tonnage on account of these improvements.

It would also give the naval architect a free hand in designing the most suitable and the safest vessel, without having the fear of an unduly high register tonnage before his eyes. It would also save him the humiliation of designing steamers, the main feature of which is an unfairly low nett register tonnage obtained at the expense of other good qualities.

Last, but not least, it would enable harbour and other authorities to levy dues on a basis that would return a revenue in direct proportion to the services rendered, and bear with more nearly equal fairness on all ships.

That the displacement basis for tonnage is open to objection, I am well aware. Some of these objections I know, others no doubt will be stated in the discussion which I hope is about to follow this paper.

Instead of stating these objections and meeting them, I prefer to wait till the close of the discussion, when we shall have all the adverse opinions before us.

I am not sanguine enough to hope that all present will agree with me that displacement is the best basis for tonnage, but as the object of our meeting to-night is to throw light on this tonnage question, any adverse criticism shall be welcomed by me at all events.

Mr. JAMES TURPIN—I have listened with much pleasure to Mr. MacIlwaine's paper recapitulating the different phases through which the tonnage question has passed, and I quite agree with him that the displacement basis on which to charge dues is by far the best. This question has been a subject of controversy for a great many of years. I remember back in 1882 a very able paper was read before the Institute of Naval Architects, on which there was a long and interesting discussion, and amongst other suggestions for the measurement of tonnage that were put forward was that advocated by Mr. MacIlwaine to-night. With the displacement tonnage as a basis for paying the dues it would be a pity to have any deduction, because that would admit of anomalies creeping in just as in the systems of measurement that have been in existence hitherto. I think that the difference between the light displacement and the load displacement would be a good basis for levying the dues on any vessel from which there should be no deduction whatever, because any little difference that may arise with regard to the different kinds of cargo carried would soon adjust itself in the change of freights. It would simply mean that our Board of Trade friends would have to measure the outside of a ship instead of the inside, which would be much more simple. There would be a great difficulty of course in altering the preseut basis for the payment of dues, because the existing system is adopted by all the maritime countries in Europe, and by the United States, so that it would mean a great revolution. It would, however, be only a question of time.

Mr. CONNEL—Mr. Chairman, as you have asked me to speak, I presume that I will require to say something in answer to your call; I did not come here to-night with the view of criticising Mr. MacIlwaine's paper. I think that one could not

discuss such a very thoughtful paper without having given a considerable time to the study of the subject of tonnage immediately beforehand, and that I have not done. I may say I would be against Mr. MacIlwaine's view of the displacement basis for at least one reason; you might have a large light ship —take for instance the vessel launched to-day—and between that ship's light weight and her load displacement you have a given quantity. You might take that ship and fit her out for the cattle trade, and put 500 or 600 tons additional weight on board. Well, there you would have a ship, presumably a better earning property, yet she would be taxed to the extent of, say 600 tons less than before. That is one objection which I see to the displacement basis. Another thing which occurs to me is this: How would you treat passenger paddle steamers, where the difference between the light draft and load draft is only a foot, and you have perhaps a ship 250 feet long occupying enormous dock space in proportion to the amount of dues which she would be required to pay?

Mr. MacIlwaine—I might be allowed to explain that I did not mean to convey that I would tax between light and load draft, but on a percentage of the whole displacement of the vessel.

Mr. Connel (continuing)—That alters the construction of the case entirely. I have misunderstood that part of the paper. As far as I have been able to study this question of tonnage, I am led to the conclusion that the tonnage measurement for the Suez Canal is probably as fair a basis as one could have. There are very special cases, such as Mr. MacIlwaine referred to, no doubt; but I think for ordinary sea-going craft the method of measuring for the Suez Canal is a tolerably fair one. One argument against the present system of allowing 32 per cent. deduction from the tonnage for propelling power is this, the system of fitting forced draught to the furnaces is becoming more and more popular yearly. It is found that a ship may have the 32 per cent. deduction when working under natural draught, but as soon as you take the large boilers out and put

small ones in, you do not get this deduction. I believe that if the 32 per cent. deduction was abolished, and we deducted instead just the space occupied by the machinery and permanent bunkers, we would have a tolerably fair deduction for propelling power in all vessels. I do not remember any other point in the paper with which I do not find myself at one.

Mr. MAXTON—I have listened with very great interest to Mr. MacIlwaine's paper, and regret very much it was not more exhaustive. I thought he was going to criticise severely the Board of Trade, Lloyds, and a lot of naval architects. I am sorry he did not say more about the anomalies in the present system of tonnage measurement. I might mention one that naval architects are generally aware of, namely, the vagueness of tonnage "length" of a vessel, and would suggest that the length on the load line and from inner post of steamers should be used. I remember some two years ago I had a great number of calculations to do in reference to the gross displacement to the upper surface of the deck. I calculated several vessels from measurements taken internally, and I found a great difference between the under deck tonnage arrived at by an accurate method and the Board of Trade under deck tonnage. I calculated the tonnages by what is considered an exact method, whereas the Board of Trade was computed by the usual rule. In one vessel about 260 feet long I found a difference of about 25 tons, so that the owner was paying dues on about 25 tons more than he should have done. In reference to the question of charging dues upon the tonnage of vessels I think there might have been something said in its favour. In one respect I disagree with Mr. MacIlwaine about paying dues upon a percentage of the gross displacement, for this reason; We should always pay in some proportion to the amount of benefit we receive, and, in the case of dues, in proportion to the amount of expenditure involved in providing accommodation for vessels. There is a considerable amount of favour, in my opinion, due to the method by which the dues are charged upon a numeral derived from the length, breadth, and draft. The draft element

is a very important one, and should be proportionately rated. I think Mr. MacIlwaine's method would be considered a refinement. I am sure the Board of Trade officials would feel very much alarmed if an Act were introduced to revise the whole of the tonnage laws in such a radical manner. Another point is this ; I really think the Board of Trade in computing a regular tonnage involving such labour, expense, and annoyance should not take cognisance of a whole lot of space in a vessel ; and the owners should only be called upon to pay for the space actually used for cargo or passengers. I have very much pleasure in supporting Mr. MacIlwaine's suggestion for registering displacement, as it would be an extremely useful adjunct especially for statistical purposes, but to adopt a percentage of displacements for fiscal purposes would embarrass shipowners, and, I fear, necessitate enormous expense and cause immense trouble, and certainly cripple numbers of trades and vessels.

Mr. A. L. Jones—It has been generally thought that the earning power of a vessel is the safe basis for assigning the tonnage, but there are different opinions as to whether the earning power is better measured by the dead weight carrying capacity or the internal cubic capacity. I think one of the chief objections to the adoption of a dead weight tonnage has been the difficulty of determining the maximum load line, because if the maximum load line were fixed it would be an easy matter to determine the displacement between the light and deep load lines. Now, however, that difficulty has been removed by the passing of the Load Line Act. But there is a distinct difference between Mr. MacIlwaine's proposal to take a definite fraction of the total displacement and the adoption of the dead weight capacity, because the dead weight capacity is a very variable fraction of the total displacement. One objection suggests itself at once when it is proposed to adopt the total displacement as the basis of tonnage, for it would then be an advantage to the ship owner to confine his engine space as much as possible ; whereas the present allowance of 32 per cent. deduction for the machinery and bunkers, provided the machinery

pace exceeds 13 per cent. of the gross tonnage, tends very beneficially to encourage the construction of fairly large engine rooms. The inducement to build light hulls would also be great, and if it be true, as we are told, that the days of steel shipbuilding are numbered, and steel is to be discarded for aluminium, the weight of the hull will be enormously reduced, and vessels constructed of aluminium will be placed at a quite unfair advantage for displacement tonnage as compared with those of steel.

Mr. W. Boyd—I agree with Mr. MacIlwaine that the displacement would be the best basis of the measurement of tonnage. I do not see why the word "tonnage" should not be done away with altogether and take "displacement" for payment of dues. There may be some difficulties, but these would soon be got over, and the Harbour Authorities could be allowed by Act of Parliament to have different tariffs for sailing ships and steamers. Regarding the international question, I think if Britain led the way others would very soon follow. I think some very great changes ought to be made in the measurement of crew spaces. Nobody knows where he is until the Board of Trade Surveyor comes down and says what he is going to have. The depth question might be taken into consideration as well as the displacement, but I think the displacement would cover everything, if properly worked, and two tariffs arranged.

Mr. F. Heyn—I should like to say a word from the commercial point of view. We have been so repeatedly harassed with changes in the rules that I think it would be a very serious and a very unfair handicap to shipowners if any further changes were to be made. All those who levy dues or taxation upon a tonnage basis have now arrived at a fairly accurate estimate of the total amount required, and really all we desire is that we should not be further interfered with. I agree with Mr. Connel, that if any change must be made, the Suez Canal basis of tonnage measurement is really a fair and right basis for getting at the actual tonnage upon which vessels should pay. The rule, if applied to sailing vessels, would, I take it, be on the same

basis—the actual cubic contents of the vessel. Another point suggested itself to me;—would not the basis of displacement as put forward by Mr. MacIlwaine tend to the ingenuity of shipowners and shipbuilders being brought to bear to build ships on as light scantling as possible, as near the aluminium type which Mr. Jones has mentioned? I don't know whether that point is really a proper one, but it seems to me that this might occur to those who wish to avoid paying dues or to pay as small dues as possible.

Mr. MacIlwaine in replying, said—I will begin by replying to the last speaker, Mr. Heyn (the chairman), as his remarks are perhaps the most damaging to my proposal to levy dues on a varying percentage of each ship's displacement, but still I think displacement is the fairest basis of comparison. Mr. Heyn says truly, shipowners wish to be left alone. That is exactly what I believe will not be the case. Since 1836, the system of taking internal capacity as a basis for measurement has been in existence, and it has been so constantly altered by subsequent Acts that shipowners have never been let alone for any considerable time, and in my opinion never will be till a substitute for internal capacity is found, and that I believe to be displacement. Mr. Heyn says the present system is fairly accurate. I think a reference to Lloyds' Register will show that my statement, viz.:—"A very great number of startling anomalies exist," better describes the state of the case. The next objection Mr. Heyn makes is really the most important, viz., that a displacement basis for tonnage would lead to building vessels of too light scantlings. This is no doubt true, but such a tendency would certainly be corrected by the Committee of Lloyds' Registry. I am very glad to have such a high authority as Mr. Turpin on my side. He says he would take displacement as a basis, and approves of it; but I think he is wrong in saying he would take it without deductions, and, with all due deference, I think Mr. Turpin has not fully considered that point, or he would not have recommended displacement pure and simple. I don't think it comes within my

province to criticise Mr. Jaffé's remarks, but from an owner's point of view there is a good deal in what he says. Mr. Connel's remarks were very much to the point. I think with a little further consideration he will probably come nearer a perfect agreement with me. He says that a ship sailing very light would pay little. No doubt that is a slight objection, but a very slight one. I quite agree with him in thinking the Suez Canal system of measurement is a better one than the present net register. Mr. Maxton thought I should have pulled to pieces the Act of Parliament, &c., &c. It is not the details of the Act I consider objectionable, it is the principle on which it is based. He proposes vessels should pay dues in proportion to their length. That proposal has been often made before, and in my opinion rightly abandoned, because it would set a premium on building abnormally full ships, which I consider an evil to be avoided. I regret that Mr. Jones is still of opinion that internal capacity is the best method of estimating tonnage. If we had sailing vessels only to deal with I might agree with him, but when steamers come in question I must say my opinion is still in favour of displacement. I must admit there is no doubt a displacement tonnage would tend to cramp the engine room space, but I believe any error of that sort would soon correct itself. I was pleased to gather from Mr. Boyd's remarks that he agrees with me fairly well. His suggestion to substitute the word displacement for tonnage is worthy of consideration, but it is the principle I contend for rather than the name. Mr. Boyd showed that he is fully alive to the present absurdities in the methods of measuring ships. I must conclude, thanking the audience for their kind attention.

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*Turnley, John (Representatives of),	Belfast.
Valentine, G. F., Sandhurst, Knock,	do.
Walkington, D. B. (Representatives of), Thornhill, Malone,	do.
Walkington, Thomas R., Edenvale, Strandtown,	do.
Wallace, James (Representatives of),	do.
Ward, Francis D., J.P., M.R.I.A., Wynncliffe, Adelaide Park,	do.
Ward, Isaac W., Ulster Terrace,	do.
Ward, John, J.P., Lennoxvale, Malone Road,	do.
*Webb, Richard T., Milecross House,	Newtownards.
Whitla, William, M.D., J.P., College Square North,	Belfast.
Wilson, James, M.E., Oldforge,	Dunmurry.
Wilson, John K., Marlborough Park,	Belfast.
Wilson, Walter H., Stranmillis,	do.
*Wilson, W. Perceval,	do.
Workman, Francis, College Gardens,	do.
Workman, John, J.P., Windsor,	do.
Workman, Rev. Robert, Rubane House,	Glastry.
Workman, Rev. Robert, B.D.,	Newtownbreda.
*Workman, Thomas, J.P., Craigdarragh,	Craigavad.
Workman, William, Nottinghill,	Belfast.
Wright, James, Lauriston, Derryvolgie Avenue,	do.
Wright, Joseph, F.G.S., Alfred Street,	do.
Young, Robert, C.E., Rathvarna,	do.
*Young, Robert Magill, B.A., M.R.I.A., Rathvarna,	do.

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Stewart, Samuel Alex., F.B.S.Edin.,	do.
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Corry, Sir James P., Bart., J.P., M.P., Dunraven,	do.
Craig, James, J.P., Craigavon, Strandtown,	do.
Davidson, S. C., Killaire House,	Crawfordsburn.
Davies, A. C., Glenmore Cottage,	Lisburn.
Dobbin, William, J.P., Park Lodge, Oldpark Road,	Belfast.
Dunville, Robert G., J.P., D.L, Redburn,	Holywood.
Foster, Thos. A., M.A., Clonsilla, Antrim Road,	Belfast.
Gamble, James, Royal Terrace,	do.
Glass, James, J.P., Carraghdarragh, Windsor,	do.
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Jones, A. L., Waring Street,	do.

Kelly, Wm. Redfern, M.I.C.E., Elgin Terrace,	Belfast.
Luther, W. Heinrich, M.D., Chlorine House,	do.
Lynn, William H., C.E., R.H.A., Crumlin Terrace,	do.
Macauley, P., LL.D., Stranmillis Road,	do.
Mackenzie, John, C.E., Lisburn Road,	do.
Malone, John, Brookvale,	do.
Matier, Alexander S., Chichester Park,	do.
Milligen, John, Donegall Place,	do.
M'Causland, William, Cherryvale House,	do.
MacIlwaine, E. N., Eglantine Avenue,	do.
M'Keller, John, Custom House,	do.
M'Laughlin, W. H., Brookvale, Antrim Road,	do.
Oakman, Nicholas, Royal Terrace,	do.
Oldham, Charles (Messrs. Workman, Clark & Co.),	do.
Osborne, Thomas Edens,	Cultra.
Paul, Thomas, Redcot, Knock,	Belfast.
Peddie, J. Finlay, C.E., Royal Avenue,	do.
Redfern, Prof. Peter, M.D., F.R.C.S.I., Lower Crescent,	do.
Reeves, Right Rev. Dr., Lord Bishop of Down and Connor and Dromore, Conway House,	Dunmurry.
Rogers, John, Windsor Avenue,	Belfast.
Ross, William A., Iva Craig,	Craigavad.
Scott, Conway, C.E., Agincourt Terrace,	Belfast.
Swan, Allan P., F.L.S.,	Bushmills
Swiney, J. H. H., C.E., Chichester Avenue, Antrim Road,	Belfast.
Tate, Alexander, C.E., Longwood. Whitehouse,	do.
Taylor, Sir David, J.P., Bertha, Windsor,	do.
Thompson, John, The Glen, Limestone Road,	do.
Turpin, James, Waring Street,	do.
Walkington, R. B., Linenhall Street,	do.
Wise, Berkeley D., C.E.,	Greenisland.
Wisnom, H., Fitzroy Avenue,	Belfast.
Withers, James, Laurence Street,	do.
Wolff, G. W., M.P., The Den, Strandtown,	do.

Report and Proceedings

OF THE

BELFAST

NATURAL HISTORY & PHILOSOPHICAL SOCIETY

FOR THE

SESSION 1892-93.

BELFAST:
PRINTED BY ALEXR. MAYNE & BOYD, 2 CORPORATION STREET
(PRINTERS TO THE QUEEN'S COLLEGE).

1894.

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CONTENTS.

Belfast Natural History and Philosophical Society.

ESTABLISHED 1821.

SHAREHOLDERS.

1 Share in the Society costs £7.
2 Shares ,, ,, cost £14.
3 Shares ,, ,, cost £21.

The proprietor of 1 Share pays 10s. per annum ; the proprietor of 2 Shares pays 5s. per annum ; the proprietor of 3 or more Shares stands exempt from further payment.

Shareholders only are eligible for election on the Council of Management.

MEMBERS.

There are two classes—Ordinary Members, who are expected to read papers, and Visiting Members, who, by joining under the latter title, are understood to intimate that they do not wish to read papers. The Session for Lectures extends from November in one year till May in the succeeding one. Members, Ordinary or Visiting, pay £1 1s. per annum, due 1st November in each year.

Each Shareholder and Member has the right of personal attendance at all meetings of the Society, and of admitting a friend thereto ; also of access to the Museum and Library for himself and family, with the privilege of granting admission orders for inspecting the collections to any friend not residing in Belfast.

Any further information can be obtained by application to the Secretary. It is requested that all accounts due by the Society be sent to the Treasurer.

The Museum, College Square North. is open daily from 10 till 4 o'clock. Admission for Strangers, 6d. each. The Curator is in constant attendance, and will take charge of any Donation kindly left for the Museum or Library.

Belfast Natural History and Philosophical Society.

ANNUAL REPORT, 1892.

THE Annual Meeting was held in the Museum, College Square North, on 21st July, 1893. The attendance included Professor Fitzgerald, B.A. (president); Rev. J. Kinghan, Dr. J. A. Lindsay, Dr. MacCormac; Messrs. R. M. Young, B.A. (hon. secretary); Lavens M. Ewart, J.P.; R. Young, C.E., J.P.; W. H. Patterson, M.R.I.A.; John Brown, (hon. treasurer), John Ward, J.P., F.S.A.; R. L. Patterson, J.P., F.L.S.; R. Patterson, J. A. Davis, J. E. Magill, J. H. Greenhill, Mus.Bac.; and John Brett, county surveyor for Antrim.

The President having taken the chair,

The HON. SECRETARY read the notice calling the meeting. He then submitted the annual report, which contained the following:—"The ordinary winter session was opened on 1st November, 1892, when Mr. John H. Greenhill, Mus. Bac., read a paper entitled 'The subject of Electric Lighting,' illustrated by experiments, &c., after which a discussion took place. The second meeting was held on 6th December, 1892, when Mr. A. Tate, M.I.C.E., read his report as the Society's delegate to the British Association. Mr. R. Ll. Praeger, B.A., M.R.I.A., described 'Botanical Rambles in County Armagh,' illustrated by specimens; and Mr. R. M. Young, gave brief 'Antiquarian Notes on Bushfoot and Ballymagarry,' illustrated with lantern slides by Mr. W. Swanston. The third meeting was held on 3rd January, 1893, when Mr. Wm. Gray, C.E., M.R.I.A., read a paper on 'Traces of Primitive Man in North of Ireland, fully illustrated with limelight slides and objects of antiquarian

interest. Mr. S. F. Milligan, M.R.I.A., followed with a brief description of some rare Irish and Mexican antiquities. The fourth meeting—a special one—was held on 25th January, 1893,' when Mr. Isaac J. Murphy read a paper on 'The Division of Angles and Arcs of Circles,' illustrated by instruments patented by the lecturer. The fifth meeting was held on 7th February, 1893, when Mr. Frankfort Moore read a paper entitled 'An Artificial Age, Port, the Patron and the Pillory.' The sixth meeting was held on the 17th February, 1893, when Miss Milligan, M.R.I.A., read a paper on 'Historic Ulster,' illustrated by numerous photo. slides, &c. The seventh meeting was held on 7th March, 1893, when Dr. C. Sheldon read a paper on 'Education : a Critical Examination of the Theory and Practice of Dr. Arnold, of Rugby,' and Mr. W. H. Patterson, M.R.I.A., gave 'Hints on Collecting Irish Folklore.' The eighth meeting was held on 18th April, 1893, when the President (Professor Fitzgerald) read 'Notes on Electric Power Supply on Tramways at Patterson, N.J.,' and Dr. Calwell gave a paper on 'The New Phrenology,' illustrated by diagrams. At all the meetings the attendance of members and their friends was large, the hall on several occasions being crowded. Owing to the number of popular lectures arranged by other societies early in the session, your Council considered it advisable to suspend their usual series, and engaged only one lecturer, Mr. John Adamson, of Rothesay, who exhibited and described a fine series of slides bearing the title 'Under Sail and Steam : a Hundred Years' Progress in Marine Architecture,' to a large and appreciative audience in the Ulster Minor Hall on 22nd March, 1893.

Your Council hope that by the commencement of next session arrangements will have been made for a series of popular lectures to be given by eminent scientists before the Society. They feel that the Society would be strengthened by extending its efforts in this direction of usefulness.

It will have been noted by members with regret that Mr. William Darragh, the faithful curator of the Museum, died on 20th December, 1892. Mr. Stewart continues to give every

satisfaction, and Mr. John Hamilton has been engaged to assist him until a permanent appointment of assistant curator can be made. Messrs. Robert Patterson and R. Ll. Praeger, M.R.I.A., continue their valuable work as secretaries of the Ulster Fauna Committee, which has issued several fresh lists and received numerous replies. The latter gentleman having been appointed assistant librarian at the National Library, Dublin, your Council regret very much that he has been compelled to retire from this Council, of which he has been a most useful member.

In presenting the statement of account, the Hon. Treasurer reports that, although the expenditure by careful economy has been much reduced as compared with recent years, the income of the Society has been still more curtailed, resulting in a small deficit.

The collections at the Museum have been augmented during the year by numerous valuable donations. Amongst these the artistically-mounted Irish birds and martens presented by Major Maxwell, D.L., and Mr. James Thompson, J.P., are conspicuous. Some of your members were lately present at the unusual event of exhuming an Irish sepulchral urn, which, with another example, has been kindly presented by the Misses Watson, of Killinchy, on whose property they were found.

The Council desire to give their cordial thanks to the local Press for their admirable reports of the Society's various public meetings.

The new constitution for the government of this Society, as finally amended, was approved and passed by the Lord Lieutenant on 19th June last, and this meeting will be held in accordance with its provisions."

The President explained that this was the first meeting held under the new scheme, and that the accounts had now to be audited in accordance with the regulation form of the Educational Endowment Commissioners.

The Hon. Treasurer presented the statement of accounts, and

Mr. R. M. Young read the report of the Fauna Committee,

which was as follows :—"The secretaries of the Ulster Fauna Committee report that their work has progressed as usual during the past year. No very important information has come to hand, but the services of several new observers and correspondents have been secured. By letters and interviews a considerable amount of information has been collected, and it has been found necessary to compile two additional lists of Irish birds, in order to increase our knowledge of breeding and migration. Copies of these are on the table for inspection. The secretaries would again urge on members and others interested in natural history the importance of assisting the Committee in every way, and information and specimens shall be gratefully received."

The CHAIRMAN pointed out that under the old rule the Council were able to make exchanges with other societies if they thought fit to do so, but under the existing scheme of the Educational Endowment Commissioners it was necessary first to hold a meeting of the Council and then a meeting of the Society to approve of such exchanges. That was the reason why they had to hold a special meeting that day after the ordinary meeting. The only other thing to which he would refer was the matter of popular lectures. They thought it was quite useless to try to carry out any large scheme of popular lectures last winter owing to the large number of university extension and other lectures given elsewhere, but this year they would be able to re-establish the course of lectures which had been given in the Museum every winter before.

Rev. Mr. KINGHAN, in moving the adoption of the reports and statement of accounts, said they they were of a satisfactory character. He wished to refer to the question of the auditing of their accounts. He did not see the necessity for having them audited in Dublin. He thought that they should be audited in Belfast, and that that and other societies in Belfast affected by the educational endowment scheme should make a united request to get the Government auditor to examine and audit the accounts in Belfast.

Dr. MacCormac seconded the adoption of the reports.

Mr. J. Brown remarked that it was exceedingly difficult to get popular lecturers for the winter season. With regard to Rev. Mr. Kinghan's suggestion with reference to the auditing of the accounts, he might say he would be very glad if that arrangement could be carried out.

The Chairman fully agreed with Mr. Kinghan and Mr. Brown on that point, and he thought it would be possible to arrange with other societies to have the suggestion carried into effect.

The motion was then passed.

Mr. R. L. Patterson, J.P., in accordance with article 32 of the endowment scheme, surrendered, on behalf of himself and Mr. Joseph John Murphy, joint trustees, their custody of the trust deeds, securities, and other documents connected with the Society.

Mr. Young, C.E., understood there was some formality to be complied with before the documents could be taken out of the custody of the trustees.

Mr. R. M. Young said that was so, and

The Chairman said they would request Mr. Patterson and Mr. Murphy to retain the documents in their possession for the present.

Mr. Patterson expressed his willingness to do so.

On the motion of Mr. R. M. Young, seconded by Mr. L. M. Ewart, J.P., a vote of thanks to the trustees for the faithful manner in which they had discharged their duties was passed unanimously.

Mr. Patterson, in acknowledging the compliment, said that no vote of thanks was required to induce him to do all that lay in his power to promote the objects of the Society.

Mr. R. Patterson and Mr. J. E. Magill were appointed scrutineers for the election of five members of Council.

The following were elected officers for 1893-4 :—President—Professor M. F. Fitzgerald, B.A., M.I.M.E., Assoc. M.I.C.E. Vice-Presidents—John Brown, R. L. Patterson, J.P., F.L.S. ;

W. Swanston, F.G.S. ; J. Wright, F.G.S. Hon. treasurer—John Brown. Hon. librarian—Thomas Workman, J.P. Hon. secretary—Robert M. Young, B.A., M.R.I.A.

The Secretary announced that the following donations to the Museum had been received since last meeting of the Society :—From Mr. Herman Hoell, barque Dovre, four king crabs from Florida ; from Mrs. Jenkins, specimen of cuttlefish taken at Helen's Bay ; from Mr. W. Swanston, a trooper's flint-lock pistol ; from Mr. John Beck, a spindle whorl, found in the souterrain under Donegore Moat ; from Mr. Thomas Workman, J.P., shells from Singapore (auricula, terebralia, potamides, &c.) ; from Mr. J. Liddle, Cookstown, a collection of fish palates, from carboniferous rocks near Cookstown ; from the Misses Watson, Killinchy, two sepulchral urns exhumed on their property near Killinchy ; from Miss Watson, a wooden mether, filled with butter, found in a bog near Portadown ; from Mr. Moses Atkinson, the sword of a Lisburn Volunteer of last century.

On the motion of the Secretary, seconded by Mr. W. H. Patterson,

A vote of thanks was passed to the donors.

Mr. John Ward, J.P., spoke of the insufficiency of space for specimens sent to the Museum, and expressed the opinion that the space at their disposal, should, as far as possible, be devoted to the accommodation of local specimens. They were very glad to receive donations from Singapore and other distant places ; at the same time, he thought they should as much as possible confine their attention to local objects.

Mr. Brown was rather afraid that Mr Ward's observations might have the effect of discouraging donations from friends of the Society living at a distance. If there was any difficulty in the matter he thought they should make an effort to increase the size of the building, so that all might be accommodated.

Mr. Patterson suggested that such specimens as they had not room for should be sent to the Free Library for exhibition.

The Chairman thought they should take all the fish which came to their net. He did not think, however, that Mr.

Ward's remarks tended in the direction of discouraging donations from a distance.

The SECRETARY—He is too good a friend of the Society to discourage any such thing.

This concluded the business of the ordinary meeting.

The CHAIRMAN then moved that those present resolve themselves into a special meeting to authorise exchange of certain duplicate Irish antiquities for geological specimens with Mr. W. Praeger, Koekuk, U.S.A. ; and, this being agreed to, moved that the meeting approve of the exchange.

The meeting gave the necessary authority, aud the proceedings then terminated.

The Belfast Natural History and Philosophical Society in Account with Hon. Treasurer
For the Year ending April 30th, 1893.

Dr. | **Cr.**

EXPENDITURE.

		£	s.	d.
To Cash paid	Printing Report and Proceedings ...	£33	11	0
,,	Printing Guide to Museum ...	4	9	6
,,	General Printing and Stationery ...	4	10	1
,,	Advertising	8	15	10
,,	Postage and Carriage	6	9	10
,,	Insurance	4	12	3
,,	Fuel and Gas	14	17	5
,,	Water Rate	2	4	7
,,	Cleaning	17	4	2
,,	Repairs and Alterations	9	1	8
,,	Stuffing Birds	3	3	0
,,	Expenses at Easter	8	14	4
,,	Deficit on Lecture Account ..	3	19	7
,,	Costs of Scheme under Educational Endowment Act	27	8	0
,,	Collector's Commission	6	7	6
,,	Sundries	1	5	5
,,	Wm. Darragh, Pension to December 31st, 1893	32	0	0
,,	S. A. Stewart, Salary to April 30th	55	0	0
,,	Wm. Miller, Salary	22	0	0
,,	J. Green, for Reporting Discussions ...	6	2	6
,,	Rent to April 30th	25	0	0
		£296	16	8
Balance due Treasurer		£14	6	8

RECEIPTS.

		£	s.	d.
By	Balance in Hon. Treasurer's hands ...	£26	4	0
,,	Subscriptions	129	2	0
,,	Do. in Arrear	0	15	0
,,	Donations	5	4	0
,,	Transfer Fees	0	4	6
,,	Interest on York Street Spinning Co Debentures	17	11	11
,,	Proceeds of 3 Shares sold	21	0	0
,,	Entrance Fees at Door to April 30th ...	24	3	9
,,	Do. Easter Monday ...	21	2	4
,,	Do. Easter Tuesday ...	2	7	3
,,	Do. Easter Wednesday ..	2	0	3
,,	Contributions from Ulster Astronomical Society (1892)	5	12	0
,,	Do. Naturalists' Field Club ...	6	6	0
,,	Do. Ulster Medical Society ..	16	1	0
,,	Do. British Medical Society ...	1	11	6
,,	Do. Ulster Amateur Photo. Society	2	9	6
,,	Do. Mr. Swanston	0	15	0
,,	Balance	14	6	8
		£296	16	8

J. Brown, *Hon. Treasurer.*

DONATIONS TO THE MUSEUM, 1892-93.

From Wm. Allaby, Esq.

A stuffed specimen of the Kittiwake gull with three legs, shot in Pentland Firth.

From Donald Cameron, Esq.

Eggs of the large partridge, the small partridge, and the mirasol, from the Argentine Republic.

From Robert Darragh, Esq., Portadown.

A bronze celt or palstane, dug up in a bog near Dromara.

From John Henry Davies, Esq., Glenmore.

Two specimens of the saw fly (*Sirex gigas*) from near Lisburn.

From Miss Fleming, Manchester.

One pair of sandals.

From Miss Adelaide Gage, Rathlin.

155 bird skins from Rathlin Island, and 85 eggs of sea-birds from same locality.

From Mrs. Graham, Knock.

A number of specimens of fossils and minerals.

From John Hamilton, Esq.

Specimens in spirits of horned toad, chameleon, green-tree frog, etc.

From Hugh Hunter, Esq., Ballymagarry.

Portion of an ancient water pipe from Ballymagarry, Co. Antrim.

From L. L. Macassey, Esq., B.L.

A large glaciated limestone boulder found at the filtering beds.

From Major Maxwell, D.L.

A case of stuffed animals, marten and prey, shot at Finnebrogue, and pictorially mounted to illustrate life history of *Mustela.*

Fron W. F. M'Kinney, Esq., Carnmoney.

A column of jointed prismatic basalt from Killead.

From Thos. Edens Osborne, Esq.

A stuffed specimen of the globe fish.

From —— Osborne, Esq., London.

A case of tea from Tibet ; the first brought to this country.

From Robert Patterson, Esq., Malone Park.

A fresh specimen of the whiting pout (*Morhua lusca*), caught in Lough Foyle.

From R. K. Sinclair, Esq., Andersonstown.

A specimen of gulf weed (*Sargassum*) from the Gulf Stream.

From James Thompson, Esq., J.P., Macedon.

A case of birds, corncrake and young, set up pictorially to illustrate the life history of *Crix Pratensis.*

From Miss S. M. Thompson, Macedon.

Specimen showing ripple marking and sun cracks, from quarry at Scrabo Hill.

From Robert J. Welch, Esq.

24 platinotype photographs of Irish antiquities.

From Thomas Workman, Esq., J.P.

Specimens of shells from Burma, Singapore, and Egypt ; also Lepidoptera from Mulmein and from Madagascar.

From Isaac Murphy, Esq.

Instruments invented by Mr. Murphy, for measuring the divisions of angles, and arcs of circles.

From W. Swanston, Esq., F.G.S.

Portrait of Mr. Darragh, late Curator of the Museum.

ADDITIONS TO THE LIBRARY, 1ST MAY, 1892, TILL 1ST MAY, 1893.

ADELAIDE.—Transactions of the Royal Society of South Australia. Vol. 15, parts 1 and 2; and vol. 16, part 1, 1891. *The Society.*

AUSTIN, Texas.—Transactions of the Texas Academy of Science. Vol. 1, No. 1, 1892. *The Academy.*

BERLIN.—Verhandlungen der Gesellschaft für Erdkunde zu Berlin. Vol. 19, parts 4-10, 1892; and vol. 20, parts 1-3, 1893. *The Society.*

BIRMINGHAM.—Proceedings of the Birmingham Philosophical Society. Vol. 7, part 2; and vol. 8, part 1, 1890-92. *The Society.*

BOSTON, U.S.A.—Proceedings of the Boston Society of Natural History. Vol. 25, parts 3 and 4, 1892. *The Society.*

BREMEN.—Abhandlungen herausgegeben vom Naturwissenschaftlichen Vereine zu Bremen. Vol. 12, part 2, 1892. *The Society.*

BRESLAU.—Zeitschrift für Entomologie herausgegeben vom Verein für Schlessiche Insektenkunde zu Breslau. Part 17, 1892. *The Society.*

BRIDGEPORT, Conn.—List of Birds found in the vicinity of Bridgeport, 1892. *Bridgeport Scientific Society.*

BRIGHTON.—Annual Report of Brighton and Sussex Natural History Society, and abstracts of papers, 1891. *The Society.*

BRUSSELLS.—Société Entomologique de Belgique. Comptes-Rendus des Seances, 1891. *The Society.*

Annales de la Société Royale Malacologique de Belgique, vol. 25, 1890 ; and Proces Verbaux des Seances, Sept.—June, 1891. *The Society.*

CALCUTTA.—Records of the Geological Survey of India, vol. 25, parts 2-4, 1892, and vol. 26, part 1, 1893 ; also index to first twenty volumes of Memoirs, and index to Palæontologia Indica up to year 1891. *The Director of the Survey.*

CAMBRIDGE.—Proceedings of the Cambridge Philosophical Society. Vol. 7, part 6, 1892. *The Society.*

CAMBRIDGE, Mass.—Bulletins of the Museum of Comparative Zoology at Harvard College. Vol. 16, no. 11 ; vol. 23, nos. 1, 2, 3, 4, and 6 ; and vol. 24, nos. 1 and 2 : also Report of the Curator. *Alex. Agassiz, Curator.*

CARDIFF.—Report and Transactions of the Cardiff Naturalists' Society. Vol. 24, part 1, 1892. *The Society.*

CASSEL.—Bericht des Vereins für Naturkunde zu Kassel, 1892. *The Society.*

CORDOVA, Argentine Republic.—Boletin de la Academia Nacional de Ciencas en Cordoba. Vol. 10, part 4 ; and vol. 11, part 4, 1889-90. *The Academy.*

DANTZIC.—Schriften der Naturforschenden Gesellschaft in Danzig. New series, vol. 8, part 1, 1892; and part 2 (Festschrift), 1893. *The Society.*

DUBLIN.—Scientific Transactions of the Royal Dublin Society. New series, vol. 4, parts 9-13, 1891 ; and Proceedings, N.S., vol. 7, parts 3 and 4, 1892. *The Society.*

EDINBURGH.—Proceedings of the Royal Society of Edinburgh. Vol. 18, 1892. *The Society.*

Proceedings of the Royal Physical Society. Session 1890-91 and 1891-92. *The Society.*

Laboratory Reports of the Royal College of Physicians of Edinburgh. Vol. 4, 1892.
The College.

EMDEN.—Jahresbericht der Naturforschenden Gesellschaft in Emden, pro 1890-91. *The Society.*

ESSEX.—The Essex Naturalist. Vol. 5, no. 12, 1891; and vol. 6, nos. 1-12, 1892. Also Journal of Proceedings of the Essex Field Club, part 2, 1884-87.
The Club.

FLORENCE.—Bullettino della Societa Entomologica Italiana. Parts 1-4, 1892-93. *The Society.*

GENOA.—Bollettino della Societa di Letture e Conversazioni Scientifiche di Genova. Anno 15, two parts, 1892-93. *The Society.*

GIESSEN.—Bericht der Oberhessischen Gesellschaft für Natur- und Heilkunde. Vol. 28, 1892. *The Society.*

GLASGOW.—Proceedings of the Natural History Society of Glasgow. New series, vol. 3, parts 2 and 3, 1892. *The Society.*

Proceedings of the Philosophical Society. Vol. 23, 1892; and Index to Proceedings from 1841 till 1889. *The Society.*

HALIFAX, N.S.—Proceedings of the Nova Scotian Institute of Natural Science. Ser. 2, vol. 1, part 1, 1891.
The Institute.

HALLE.—Nova Acta der Kaiserlichen Leopoldina-Carolinischen Deutschen Akademie der Naturforscher. Vol. 55, no. 1; and Leopoldina, part 27, 1891.
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BELFAST

NATURAL HISTORY & PHILOSOPHICAL SOCIETY

SESSION 1892-93.

1st November, 1892.

Professor M. F. FitzGerald, B.A., C.E., in the Chair.

John H. Greenhill, Esq., Mus.Bac., (Member of the Institute of Electrical Engineers), gave a lecture on

ELECTRICITY AS AN ILLUMINANT.

A large number of electric lamps, supplied from a storage battery, were arranged in the hall for the purpose of illustration and experiment, with a number of other electrical appliances, including a very powerful coil, designed and constructed by Mr. John Brown, who exhibited its power in a series of interesting experiments. Various kinds of oil and gas lamps to aid the work of illustration and comparison of the different illuminants in common use were lent by Messsrs. Richard Patterson & Co., R. Patterson & Son, W. Coates & Son, T. E. Osborne, and Riddell & Co.

Mr. Greenhill, after referring to the scientific principles of lighting by such illuminants as gas and oil, proceeded:—In the case of electric light the luminosity may, and does, occur in some instances from the combustion of minute particles of carbon, as in the arc lamp, or it may arise from the intensely heated condition of a substance due to the flow of the electric current through it, as in the incandescent or glow lamp, in which no combustion practically takes place at all.

The lecturer, after given a brief history of the development

of the electric light, exhibited a number of photographic slides showing the various appliances used in the production of the light at the various periods of its history. He then described the different systems of using the electric current for lighting, and proceeded :—

The alternating current is now employed in lieu of an interrupted direct current, because it is more powerful in its effects, and presents far less difficulty in its management than would arise from the break in a high tension current. The direct current method, however, may be adapted to high, medium, or low pressures, according to the area which it has to supply and the distance at which the generating station is placed. For comparatively small sections, more especially where the generating station can be placed pretty near to the area to be lighted, the low pressure direct system can be employed, and if the three-wire plan, patented by Dr. Hopkinson in 1882, is adopted, a saving of 40 to 50 per cent. in the weight of the cables can be effected. It is a controverted question, however, which is the best system for central station supply. Each has its advantages under certain conditions. There is no doubt that for great distances the high-pressure alternating currents, with transformers capable of reducing the pressure at once or by steps, offer many and perhaps almost overwhelming advantages. At Frankfort-on-the-Main last year the current for lighting a great many lamps at the Exhibition was generated at Lauffen-on-the-Neckar, distant 108 miles. It is notable that in this instance the current is generated by the dynamo at the low pressure of 50 volts and 4,000 amperes, requiring for this purpose about 300 horse-power, which is supplied by a turbine worked by the falls of the river. This low-pressure current passes immediately through a transformer, which raises the pressure of the current to 16,000 volts, but with a corresponding reduction in the amperes, and the transformed current is then conveyed to Frankfort by three small wires of No. 8 gauge, which may be roughly described as about the size of the stem of a clay tobacco pipe. At Frankfort the current is

again transformed down to 75 volts, and used for lighting and motor purposes. Alternating current motors are quite feasible, but they do not appear to be so simple to start as those for direct currents. A noteworthy feature of the Frankfort-Lauffen current is the employment of the three wires, each conveying three separate alternating currents flowing in separate phases, following each other like a current of water actuated by a three-plunger pump. This method seems to overcome the defects of alternating motors, and it is said to prevent any disturbance by induction to contiguous telephone or telegraph wires. It also reduces the danger inherent in all high-pressure currents, more especially of the alternating or intermittent kind. Possibly without going very exhaustively into the respective merits of the various central supply systems, I may be allowed to give my opinion that for Belfast probably the direct current is preferable. For arc lighting it is unquestionably the best. A great advantage it possesses is that it provides for the use of storage batteries, which are a reserve in case of emergency, and these can be charged up during the day, when the lighting load is not heavy.

With reference to the comparative cost of electric light and gas, it has been often said that figures may be made to prove anything. To the general question whether or not the electric light is cheaper than gas, my answer is that under special conditions it is cheaper and under other conditions it is dearer. The conditions which are advantageous to the electric light are wide spaces with high ceilings, in which arc lights can be employed. The longer the hours per annum in which the light has to be kept in operation, the more advantageous for electricity. This arises from the fact that one of the most serious items in connection with electric light installation is the interest and depreciation allowance on the first cost. I always reckon these as amounting to 9 per cent., viz., 5 per cent. for interest and 4 per cent. for depreciation. The average hours for mill or workshop lighting are about 450 per annum, hence the 9 per cent. must be debited to these hours. It is manifest that if the

hours of lighting were only 225 per annum, the interest for each hour would be double compared to that for the 450 hour calculation. Take a test case of a factory requiring 500 lights of 16 candle-power,and we will assume that there is sufficient margin of engine power to drive the dynamo, which of course is favourable to the comparative cost of electric light to that of gas. On the other hand, electric light installations are generally handicapped as against gas if the latter is already in operation, because the interest on the electric light plant is debited to it, whereas no interest is charged to the gas fittings after they have been erected. With new buildings the case is different. The lecturer proceeded to give a number of figures and details with reference to the proportionate cost. His conclusion was that 500 electric incandescent lights used for 450 hours a year in a mill or works where spare engine power can be used for driving the dynamos will cost £144 17s. 6d. If the arc light can be used—as it can in the case of factories or shops having high ceilings and large space—the cost will not be more than half that amount. The cost of 500 gas lights—basing the calculation on an expenditure of six cubic feet per hour for each lamp, and on the price of gas at 2s. 7d. per thousand feet, would be for the same amount of time—450 hours per year—£174 7s. 6d., and adding £8 for incidental expenses, such as renewal of burners, &c., would bring it up to £182 7s. 6d. Where lights are used for a shorter time, however, the case is very different, and the result comes out most unfavourably for the electric light. Take 350 hours a year, for instance, in a shop or other place where special power has to be supplied to drive the dynamo, the cost will be some £220 12s. And if the supply is taken from a central station the figures are still more startling, for, taking it at 6d. per Board of Trade unit—it is contemplated, I believe, to charge 7d. in Belfast—the cost for the current alone for these lamps will be £284 7s. 6d., and other expenses will bring the total cost up to £356 7s. 6d., as against £220 12s. where the consumer puts in his own plant for driving the dynamo. The cost of gas under similar circumstances will be only £165 12s. 6d.

I am not here to advocate or to condemn any system of electric lighting, but although these central stations have been successful hitherto, and are being every day more largely adopted, notwithstanding the greatly increased cost, I should not like to have the responsibility of running such a station in Belfast. I maintain that it would be far better and cheaper for anyone requiring from forty to fifty lights to put down a small gas-engine of his own, provided the hours of lighting are more than 350 per annum. Although, as I have pointed out, dearer under some circumstances, and perhaps in most cases, than gas, the light is undoubtedly a great advantage, and is daily receiving a large and more extended recognition at the hands of the public. Modern science has overcome nearly, if not all, the difficulties that attended its early employment as far as efficiency went, and probably the objection of greater cost as compared with gas under certain circumstances will be removed before long, in which case its superiority as an illuminant cannot fail to be recognised.

Mr. James Perry—I think it right to begin by thanking the Society for allowing me to speak to this meeting here. I want to tell the people here something as simply as I can of my own connection with electric lighting during the past four years. Four years ago this day I took possession of the old flour mills, Galway. I took a roller mill out of its position, and placed a compound dynamo on its site. The Gas Company of that town up to that time were paying a dividend of 7 per cent. I appeared before the Town Commissioners, and I proposed to light the town for them. Early in the year, they agreed to accept tenders for the lighting. I tendered for the ordinary sixteen candle lamps at £2 ; they had hitherto been paying £4. Our tender was actually £1 19s. 6d., because I thought, as an old tendering hand, it was a safe thing to take off the odd sixpence. The Gaslight Company tendered at £2, and got the job ; but from that time till this they have not paid a penny of dividend. They went in for Bray lamps and a great many other things of that kind, and these ran away with

whatever money they had in hands. We are supplying the docks of Galway for the last two years. We have simply a couple of arc lamps and eight fifty candle incandescent lamps. Mr. Greenhill quoted at the beginning of his address the cost of a Well's light, and I find that we supply a 10 ampere lamp for the same cost as a Well's light. We are putting in an installation in the *Galway Express* newspaper office, and we intend to print the newspaper and all the jobbing work by electricity. The way we charge for that is 2d per hour per horse-power. Of course that is dearer than a gas-engine working at the Belfast price, but it is not dearer than a gas-engine working at the Galway price of gas, which is 5s. 6d. I may say that our central station only costs £100 a year to run. We have spent up to the present £7,000. I don't at all agree with Mr. Greenhill when he says that a private installation can compete with a central station if it is properly managed and a fair price charged. If you work with a steam-engine and get up steam for a few hours lighting there is an enormous waste of coal, etc. One gentleman in my district has a special lighting station of his own, and he actually pays £50 a year for repairs alone. My position is that electricity can be generated in a central station and sold as cheaply as gas manufactured from coal in the same place. One does not need to be an electrician to run an electrical central station; the fact is we run ours with two labourers. An important and serious difficulty in setting up a central station for the supply of current to your consumers is having to wait for your consumers. When gas was established it had not the competition that electric light has; it had only to beat down the old candles and very bad oil lamps. You must be prepared for some time to work without profit, and possibly at a loss.

The duty of a steam-engine very much depends on the constancy of its work. You have heard from Mr. Greenhill of 6d., 7d., and 8d. a unit being charged; but Mr. Preece, the electrician of the Post Office, has discovered that a steam-engine generating electricity for electro-plating can produce it at one-third of a penny per unit;—the reason of this, is, that

the operation is continuous. The difficulty with the gas-engine for generating currents is the irregularity of its motion.

Mr. GREENHILL—Gas-engines are made to give a practically uniform and steady current, as I can prove. I am sorry to interrupt the speaker, but I am bound to correct him in the interest of the gas-engine manufacturers.

Mr. PERRY (continuing)—I am glad Mr. Greenhill has seen one of these perfect gas-engines. He merely forestalls me by a day or so. I was going to say I believe this difficulty will be overcome in the near future. My authority as to gas-engines is probably quite as valuable as that of Mr. Greenhill. The standard book on gas-engines is one written by Professor Robinson, of Nottingham, and that book in its preface, professes to be an extension of my brother's lectures at the Finsbury College. I wrote to my brother on this very point. Mr. Greenhill appears to have information that my brother has not yet, though he tells me that, for the present course of lectures he is delivering, he has obtained from the manufacturers almost every type of gas-engine. With gas-engines steady enough for generating currents, we could produce electricity for lighting purposes at a price which would compare with Mr. Preece's price for electro-plating, because this would completely solve the question of cheap storage. It is found in Crossley's place that they are able to drive their gas-engines at 0·8 of a penny per indicated horse-power ; that is a price no steam-engine can touch. I believe the age of gas will be succeeded by the age of electricity, because in the best steam-engine we only turn 5 per cent. of the energy of the coals into power; but if we could turn the energy of the coals into electrical energy without the intervention of a steam-engine, then in my opinion we should have a very great saving, and the age of electricity would have dawned.

Mr. J. M. BARBOUR—My experience is entirely confined to electric lighting as used in spinning mills. There seems to be a want of confidence with millowners at present in regard to electric light. They seen to look upon it as a new idea : they

think it is liable to go out at any minute without cause. I have not found it guilty of any of these vagaries. There is one danger that possibly may not occur to all regarding the supposed instability of the light, *i.e.*, in a mill if the light were suddenly to go out, the first move of the hands would be to throw off all the machinery; and this in the case of an engine not properly provided with regulating apparatus might cause a serious breakdown. On the other hand, there are considerable advantages. The light can be turned on at any moment when required. In a mill a great deal of the floor space is covered by machinery, and to place the gas in the most convenient part would necessitate climbing on to this machinery in order to light it. With electric light you can place the light exactly where you want it. Another thing is the absence of risk from fire. Electric light is safer, as with it you do not require to carry naked lights about. At Hilden we have gas at 3s. 3d. per thousand feet, and by taking our gas consumption for the year and keeping a record of the number of lights I find the cost per gas burner comes out to 7s. 3d. a year;—in this comparison there is a difference of 10d. per light per annum in favour of the electric light, which is a material saving. At Dunmurry we make our own gas, and, without any allowance whatever towards keep up of gas plant, we find that the cost per burner per year comes to 6s.

Mr. Macassey—There is no doubt a great deal of prejudice against the introduction of electric light into houses. For open spaces and large factories it is in my opinion the best light, but I do not myself anticipate that any of us present will live to see the time when gas as an illuminant will be driven out of our private houses and offices. The matter has been fully explained now, and the question for the Belfast ratepayers is what should our representatives in the Town Hall do with this question? Should we sell our gas works for old iron, or should we continue to keep them up in an efficient state and go in for electricity on a small scale? I have made enquiries in London and other places where electricity has been introduced, and so far as

I can ascertain, they find that the cost, without taking into account the putting in of new fittings, is something varying from one-third to one-half more, that is, that if they pay 1s. for the gas they have to pay 1s. 4d. to 1s. 6d. for the electric light. That appears to me to be the case for the Belfast public to consider. Are they prepared to go in for the electric light at this additional cost? I do not think they have arrived at that yet. I think the tendency of public opinion is that the Corporation should go in for lighting a considerable area in the centre of the town. Still there would be room for the gasworks, and the Corporation would make a fearful mistake if they were to think of throwing over the good bargain they obtained when they purchased the gasworks some years ago.

Mr. ANDREWS—Owing to the lateness of the hour you will excuse me saying anything more than what occurred to-day. The decision arrived at by the Corporation to-day was a very prudent and wise one; they determined to go ahead at once with an initial installation of 10,000 lights. These lamps will be principally suitable for lighting shops, hotels, etc., in the centre of the town, and if this installation proves successful further areas may easily be added. Mr. Greenhill's figures were, I think, exceptionally favourable to the cost of electric light in a private installation, and Mr. Barbour has corroborated them as nearly as possible. Mr. Greenhill in his first calculation figured out that the cost of the unit would be somewhere between 2d. and 6d. I take that to be the cost at the station, and not the cost as delivered to the customer, because there is considerable loss from the mains. If we can get the electric light at 6d. or 8d. a unit delivered, the people of Belfast will take it up. Mr. Perry said he considered electric light can be manufactured as cheaply as gas in the same place. I cannot understand that statement, because the cost of coal varies enormously in different places.

Mr. PERRY—Allow me to explain. You make gas from coal; you generate electricity from coal. Then in the same place assuming coal to be the same price whether you generate elec-

tricity or gas, I say that electricity can be produced as cheaply from coal as gas can be in the same place.

Mr. ANDREWS—That is certainly a very good statement in favour of electricity, and we sincerely hope it will be carried out. In Galway their electricity is entirely produced by water-power.

Mr. PERRY—But we had to buy our power.

Mr. ANDREWS—Might I ask at what ratio would that water power cost you per indicated horse-power?

Mr. PERRY—You cannot talk of the I.H.P. of turbines. The indicated horse-power of a steam-engine is the rate of work actually done by the steam in the cylinder;—it is given by the area of the indicator diagram: the actual horse-power would be found by a brake on the main shaft: it is always less than the I.H.P. In the case of turbines the gross horse-power, viz., $\frac{\text{lbs. of water per min.} \times \text{feet of fall}}{33{,}000}$, is probably the analogue of I.H.P. At Galway this is more than 200 H.P., and we are able to deliver 100 H.P. as electricity at consumers' lamps throughout the 24 hours. By making use of storage, running 24 hours, and discounting for loss, we can deliver during 6 hours of lighting 300 H.P. at lamps: *i.e.*, our water power capacity is about 6,000 eight candle lamps for six hours a day. The capital cost of this is about £3,000, which at 5 per cent. is £150 a year, and works out to be less than $\frac{1}{10}$th penny a unit. However, this calculation does not close the question; the first cost of storage batteries has to be added and their upkeep, and a comparison made with the amount of storage advisable in the case of generation from coals. I cannot give the information you want right off, because it involves a little calculation. We have the water power attached to the mills in Galway. We have no rent to pay at all; we bought our mills and own them in fee, and there is interest on the cost of the construction. We have to pay for the general maintenance. As I have said we have spent £7,000. £100 a year runs it, and we are earning a fair dividend at the present time, though only a few places are on.

Mr. ANDREWS—Then, if you told the meeting at what horse-power you run ?

Mr. PERRY—We are able to deliver 100 electrical horse-power for the 24 hours.

The PRESIDENT—I wish to ask Mr. Perry what is the horse-power actually delivered in Galway per 6 hours ?

Mr. PERRY—We were delivering 26 horse-power the other night when I was there. It would run between 10 and 30.

Mr. ANDREWS—One more question : Supposing the Corporation were to offer Mr. Perry a contract for supplying 10,000 lights, would he be willing to bind himself to supply that light at the price he mentions—viz., 3d. per Board of Trade unit delivered at the station ? He says he could produce it at 2½d. provided he was contesting against gas at 2s. 9d.

Mr. PERRY—I am prepared to make this offer to the Belfast Corporation. I will prepare figures for them, and if these figures are not carried out I shall not expect to be paid for them, but if they are carried out I will be paid.

The PRESIDENT—You mean that you consider the thing could be sold at 3d. per unit ?

Mr. PERRY—I do decidedly, on the assumption that there is a sufficient number of consumers on the mains.

Mr. ANDREWS—That certainly would be a very great boon to the consumers of Belfast. I have no doubt that if Mr. Perry can produce the electric light at anything near that price there will be an enormous demand for it.

Mr. STEWART—I would desire in the first place to thank you for your kindly references to my recent work as a journalist. I have seen a great many of the electric generating stations in Great Britain, and the process of manufacture of a number of the dynamos to which Mr. Greenhill has referred, and I must say that he has given a lucid description of them. Upon this important question of cost, which has given rise to so interesting a debate, I may mention that in Bradford I learned that for a time the electric lighting station had been supplying light absolutely free ; but it turned out that this was the fault of the

ammeters, which had ceased to register the amount of current passing through them. It is hardly necessary to say that this defect was speedily remedied. There is no doubt that the cost of electric lighting for domestic purposes is in large towns higher than the cost of gas. It is at least twice, and in some instances two and a half times as dear. There are however many advantages possessed by electric light over gas. Convenience is undoubtedly one of these advantages. You enter a sitting room, drawing room, or library, and you switch on the light at the door. If you leave the room for five or ten minutes you can switch the light off. If you were burning gas in the same place the chances are you would not take the trouble to turn off the gas for brief periods. The electric light is also much healthier. The Postmaster-General has found that he saves £600 per annum at the General Post Office in London because of the smaller number of absentees through illness, and he has introduced electric light in Bradford and other places, where he finds similar good results. I wish to refer to an aspect of the question which has been overlooked, viz., the possibility of electricity being used for cooking and domestic purposes. There are radiators by which rooms can be heated by means of electricity, there is a great variety of cooking apparatus, and I have seen electric cigar lighters. Although at the present time such domestic arrangements are expensive, the electrical engineers are confident that in a few years there will be great improvements, and that electric cooking, heating, and lighting will be great accomplished facts.

Professor FitzGerald—It seems to me that in effect Mr. Perry's proposition of supplying electricity at a charge of 3d. per unit amounts in reality to a charge of probably 4½d. or 5d. per unit when the installation is put in, for this reason, that Mr. Perry limited himself to 3d. a unit subject to the proviso that the density of supply should correspond to the number of gas-lights per yard of gas main in the same district. I consider that the additional cost of electric lighting ought not to be a barrier to its employment ; it is really a matter of paying a higher price for a light of higher quality, apart from quantity.

6th December, 1892.

Report of Mr. A. Tate, C.E.,

Delegate from Belfast Natural History and Philosophical Society to Meeting of British Association at Edinburgh, 1892, *on the Conference of Delegates of the Corresponding Societies at that Meeting.*

The Conference held two meetings, which were presided over by Professor Meldola. Ten other members of the Corresponding Societies' Committee and Delegates from thirty-one Societies attended.

I have been furnished, on your behalf, with a copy of the report of the proceedings of this Conference, and also with a list of the various Committees appointed at the late meeting of the Association. The Secretary, in sending them, with request that they should be brought under your notice, adds :—" I am also requested by the Corresponding Societies' Committee to ask you to urge upon your Society, and its members individually, the importance of taking part in the work of as many of the Committees mentioned in the accompanying list as may be practicable in your district."

I will mention a few of the Committees included in the list referred to, with something in regard to the work already done :—

The Application of Photography to the Elucidation of Meteorological Phenomena.

This Committee was formed in 1891, at the Cardiff meeting, and already valuable results, especially in regard to cloud forms,

have been exhibited, and prepared for being placed properly on record. The success which had attended the labours of the "Geological Photographs Coummittee" encouraged the formation of this one.

Besides attention to clouds, lightning-flashes, &c., it was, at the late Conference, specially asked that the effects of storms and floods should be recorded wherever possible. In all cases, any needed explanatory memoranda should be noted at the time, and appended to the prints when sending them forward.

Erratic Blocks Committee.

This Committee made their twentieth annual report this year. A reference to these reports will show what a large mass of information has been collected and placed on record. In glancing through many of these reports, I regretted much to have noticed that Ireland seems to have given but little aid to the work. The district which may be considered as belonging to this Society is of great interest from the point of view of this Committee.

Geological Photographs Committee.

This Committee was first appointed in 1889, at the Newcastle-on-Tyne meeting. Already an encouraging amount of work has been done and exhibited in the geological section-rooms. Seven hundred photographs were reported at the late Conference as having been received.

Pre-Historic Remains Committee.

This Committee, which has been in existence since 1887, has accomplished and placed on record a large amount of information of great value, and has been of great service in securing attention to, and the preservation of, some of the most important evidences of the pre-historic inhabitants of the country which still remain. Mr. Gray has specially acted as a reporter from this district in this matter, and has presented the information in a very con-

venient form. This is embodied in the report of the Committee, published in extenso in the British Association report for 1889. He, I doubt not, would be ready and desirous to receive further information for publication in supplementary reports.

Two other subjects remain, to which I desire to ask your attention ; these are, the "Protection of Wild Birds' Eggs," and the "Disappearance of Native Plants." In both cases the indiscriminate and thoughtless collector is probably the main root of the evil. It was stated at the late meeting, and appears in the report, "that in Edinburgh there was a gentleman who made it his boast that he had over 100 eggs of the golden eagle."

These Conferences, on their present basis, date from the year 1884, and owe their existence to the felt need for a better means of utilising the labours of the scientific societies scattered all over the country. This feeling was expressed in the following resolution, passed in 1881 at the York meeting, viz., "that the Council be requested to consider the number and position of delegates from scientific societies, and the regulations which should be adopted for governing their relation to the Association." The eventual outcome of this resolution was a report, presented to the Southport meeting in 1883, one paragraph in which may be quoted, as indicating the Committee's appreciation of the importance of the object in view :—

"Believing that the British Association is fitted, by its constitution and position, to become an organising centre of local scientific work, and that, through an extension of the system of delegation from scientific societies, which has already been recognised in the rules of the Association, this object may be attained, the Committee venture to make the following proposals, thrown into the form of rules."

The rules so proposed were adopted, and are those now acted on. Since they were adopted, great progress has been made; much interest has been taken in all the Conference meetings by leading permanent members of the Association (specially I may mention the general Secretary, Sir Douglas Galton); and

since 1886 the Conferences have been placed on a par with all the sections, in having the power to send forward, direct to the Council, any resolutions or recommendations they consider desirable.

Mr. R. Lloyd Praeger, B.E., M.R.I.A., delivered a Lecture on

BOTANICAL RAMBLES IN COUNTY ARMAGH.

The County of Armagh, he stated, constituted part of the tenth botanical district of Ireland, which district had not received by any means a large amount of attention from Irish botanists. In view of the approaching publication of a new edition of "Cybele Hibernica," the standard work on the flora of Ireland, further information respecting the plants of district 10 was desirable, and with the view of supplying this information, the lecturer had spent three weeks during the past season in investigation of the flora of County Armagh, the most easterly of the five counties included in the tenth district. The geological and physical features of the county were first described, with the aid of a large coloured map, and it was pointed out that County Armagh presents a variety of surface, including extensive bogs, lakes, and rivers, and tolerably high mountains, and also varied geological formations, embracing Tertiary clays and basalts, Triassic sandstones, Carboniferous limestone, Ordovician rocks, and ancient granites and basalts. Mr. Praeger's first explorations were made in North Armagh, where lies the great expanse of Lough Neagh, fringed with miles of peat bogs. The waters of the lough and of the rivers and canals which connect with it yield in abundance a group of plants, most of them of great beauty, that were not found in any other portion of the county—*Cicuta virosa*, *Œnanthe fistulosa*, *Butomus umbellatus*, *Sagittaria sagittifolia.* In the waters of the lough several much rarer plants were obtained, of which *Ranunculus circinatus* had not been previously found in Ulster, and *Potamogeton filiformis*

was only known from a few lakes on the western side of Ireland. The peat bogs yield a number of plants which affect such a habitat, such as the three British species of *Drosera*, *Vaccinium oxycoccos*, *Andromeda polifolia*, *Rhynchospora alba*, *Osmunda regalis*. About the lake at Loughgall and in the woods and hedgerows there a number of interesting plants occur, of which may be mentioned *Ranunculus Lingua*, *Barbarea arcuata*, *Lithospermum officinale*, *Carex stricta*, *C. paludosa*, *Cladium Mariscus*, *Chara polyacantha*. Several plants which are extremely rare about Belfast and in the north-eastern counties of Ireland were found to be widely distributed in County Armagh ; of these the most marked were *Hypericum dubium*, *Thrincia hirta*, and *Festuca rigida*. On the limestone area, which stretches east and west of Armagh, several species were found which were in County Armagh confined to this area—*Carduus acanthoides*, *Lamium album*, *Veronica anagallis*, *Juncus glaucus*, *Trisetum flavescens*, *Briza media*.

South Armagh next claimed attention, and the mountainous district lying west of Newry was explored. Along the estuary of the Newry river a number of the denizens of the salt marsh were found, of which the most interesting were *Scirpus Tabernæmontani*, *Beta maritima*, *Obione portulacoides*, *Lepturus filiformis*. On gravelly spots in this neighbourhood were found *Spergularia rubra*, *Linaria repens*, and *Diplotaxis muralis*. The glens on Ferry Hill yielded *Lastrea aemula*, *L. oreopteris*, and *Hymenophyllum tunbridgense*. The mountain flora proved exceptionally poor. Although the fine mass of Slieve Gullion rise to a height of 1,893 feet, *Listera cordata* was the only interesting species found on the Armagh hills. *Rubus Borreri* was a rare bramble that was discovered in this neighbourhood. The lecturer then gave some descriptive particulars of the interesting neighbourhood of Slieve Gullion, and touched on the ancient legends associated with the mountain and with the little lake near its summit, and on the historical and archæological features of the district.

The central portion of Armagh was next examined. In the

woods of Tanderagee grew many plants, among which were mentioned *Gallium mollugo*, *Mercurialis perennis*, *Carex pendula*, *Festuca sylvatica*. The woods of Gosford Castle yielded the curious Bird's-nest Orchis (*Neottia nidus-avis*), and on the shores of Mullaghmore Lough, near Markethill, a very important find was made, in the shape of the fine sedge *Carex rhynchophysa*, a plant which inhabits Russia and Finland, but was not previously known to occur in the British Isles.

Subsequent examination of the Lough Neagh shores and northern bogs resulted in further interesting discoveries. Here in one spot the rare grass *Calamagrostis Hookeri*, which in Britain is confined to the shores and islets of Lough Neagh, was obtained in abundance ; and the extremely rare and beautiful orchid *Spiranthes Romanzoviana* was also found. This plant has its only other European station on the shores of Bantry Bay, in County Cork ; in Asia it is found nowhere but in Kamtschatka ; while in America it is of frequent occurrence in Canada and the northern States. A gravel-pit in the neighbourhood of Armagh also yielded some rare plants, of which the best were *Silene noctiflora*, *Papaver argemone*, and *Fumaria densiflora* ; the last named has only once previously been recorded from Ireland. Mr. Praeger concluded by saying that a full account of the interesting flora of County Armagh would be published by him in the "Irish Naturalist" for the coming year, to which he referred those desirous of knowing more of the wild flowers of that district. The lecture was profusely illustrated with dried and mounted specimens of all the plants mentioned, and of many others found in the county.

6th December, 1892.

Professor M. F. FitzGerald, B.A., C.E., in the Chair.

Mr. R. M. Young, C.E., M.R.I.A., read a Paper on

BRIEF ANTIQUARIAN NOTES AT BUSHFOOT AND BALLYMAGARRY.

In the course of his paper Mr. Young said—The romantic scenery of the northern coast of the County Antrim, particularly at Dunluce and the Giant's Causeway, is familiar to us all, as are also the fine photographs of its salient features, amongst the best of which are those recently done by Mr. R. Welch, for exhibition at Chicago by the Belfast and Northern Counties Railway Company. In spite of this familiarity, there are several interesting places which escape the tourist's notice, and are practically as unknown to the public as if situated in Uganda. I have chosen as the theme of my short paper two of these localities, situated near Bushmills, from which they are each about two miles distant. One is the prehistoric settlement on the sandhills of Bushfoot, the other the former mansion of the Earls of Antrim at Ballymagarry, near Dunluce Castle.

Bushfoot, as its name implies, is the district on both sides of the mouth of the River Bush, which is here a wide, shallow stream, celebrated for its salmon and the large turbines which utilise its water for the electric railway, not to mention the distillery for the production of the barley water associated with the town of Bushmills. The sand dunes, where the settlements of the primitive folk were located, extend from the mouth of the river to Runkerry Point, a distance of nearly two miles. I was induced to explore the sand hills after reading the valuable papers by Messrs. Gray, Knowles, Buick, and others, contained in the Journal of the Royal Society of

Antiquaries of Ireland, descriptive of the settlements of the flint-working men in the County Antrim. At first my efforts to find anything of interest were fruitless, as the hollows formed in the blown sand by the action of the wind, so productive to the explorer at Portstewart and Whitepark, yielded nothing at Bushfoot but sea-worn pebbles and land shells. On questioning Mr. Thompson, the tenant of the farm through which the electric railway passes adjacent to the river, I learned that during its construction several hearth sites were exposed and pieces of pottery and bone found. The best of these specimens form part of the valuable collection of Miss Steen, Sharvagh, Bush mills. He also pointed out the place where nearly twenty skeletons were found, close to a stone circle which has been covered of late years with blown sand. I made some search at this spot, and dug up the bones of a child, associated with numerous sea shells of an edible kind, pottery, and small fragments of iron slag, indicating that the settlement had been occupied at various epochs. As no flint implements turned up I directed my attention to another site, on the Causeway side of the Bush, close to the railway bridge, where a cutting through a gravel bed had laid bare a section of the ancient ground surface about four feet below the present sward. On digging into the dark unctuous sand, mingled with charcoal, which indicated an ancient hearth, a number of flint flake knives were found, and one or two scrapers. A large part of the site had been already removed, but on excavating into the bank a remarkable feature was disclosed in the form of a low wall of sea-worn stones, arranged evidently around the enclosure of the primitive dwelling to prevent the sand falling in. It would appear as if the level of the floor had been lower than the ground surface by perhaps a foot or more. This was the method used by the primitive Ainus of Japan in the erection of their huts, as shall be described shortly. A few yards from this hearth, another was laid bare some days after by a fresh removal of gravel from the same hill. It was close to the surface of the ground, and covered with a thick growth of the sea rose. At

this juncture the experienced assistance of Mr. Wm. Swanston was obtained, and a number of flint knives and chips dug out. Mr. Swanston had been at work only five minutes when he turned up a finely-polished greenstone chisel and a fragment of a celt. I had previously found, close by, the coarse sandstone on which they were rubbed. At a stonethrow from the spot, and in the direction of the Causeway, are some large boulders of trap, each weighing considerably above a ton on the average, evidently forming the remains of a rude stone circle. These stones must have been brought from the sea shore, one-eighth of a mile distant, and placed on the surface of ground already occupied by human beings, as on excavating beneath them unmistakable flint implements were obtained in profusion. In fact, the whole district must have supported a large settlement of the early flint age, and was suited admirably to supply their wants. Deer and other wild animals would abound in the dense forests which covered the face of the country, even in Elizabeth's reign. The Bush swarmed with salmon, and the harvest of the sea was at hand, whilst the raw material for their weapons was also easily procurable. In later times these advantages were supplemented by the intercourse which could easily be carried on along the coast line in coraghs of skin, which are still used on the Donegal coast. A few words may be of interest on the subject of the probable life led by the ancient people who used these rude flint implements to kill perhaps the great Irish elk, or even the huge hairy elephant or mammoth.

Attention has been recently directed to the life pursued by existing savages in Australia and Queensland as representative of that of our own aboriginal race ; but a nearer parallel seems to be found in the Ainus of Yezo, one of the Japanese islands. This interesting people are the survivors of the primitive inhabitants of the country, driven gradually out by the present Japanese. The Island of Yezo lies near to Siberia, and is mountainous, with fertile valleys and rapid streams. It is as well wooded as our country was 200 years ago, and bears, wolves,

deer, otters, and hares abounded till recently. To this day in Yezo there are in many places great numbers of round pits, about three feet deep by ten or twelve feet in diameter, and near them are rubbish heaps, which contain pieces of old pottery, polished axes, grinding stones, flint spear and arrow heads, and fragments of bone and horn. From the shape of these pits and the traditions of the Ainus, it is inferred that the huts above them were built in the shape of a beehive hut. They consisted of poles stuck in the earth and bent over till they met in the centre, where the ends were tied together. Over the poles were laid bark and grass, and upon this earth was placed to keep out the cold and wet ; in fact, they were of the same construction as the Irish creaghts, which are mentioned as late as 1692 by Story. The hearth was placed near the centre, and the family slept around it.

Ballymagarry—viz., "The Townland of the Garden"—was probably so called from the fact that the garden which supplied the family at Dunluce Castle was situated about its centre. The site of the old mansion-house is a mile inland from Dunluce, adjacent to a clachan of cottages at the top of a hill, from which there is a glorious view of the coast line from Malin Head to the Causeway. The little that can be gleaned from its past history is briefly as follows:—It was first occupied as a dwelling-place by John Macnaghten, a nephew of Sorley Boy and cousin to the first Earl of Antrim. He died in 1630, and was buried at Bonamargey Abbey. The Lord Lieutenant of the County, Sir Francis E. W. Macnaghten, Bart., worthily sustains the ancient family name. Randal, the eldest son of the first Earl or Antrim, was born in 1609, and Richard Dobbs notes in his "Briefe Description of Antrim" (1683):—"The Lord Marquis told me that he wore neither hat, cap, nor shoe, nor stocking till seven or eight years old, being bred the Highland way. He was a proper, clean-limbed man, first married to the Duchess of Buckingham, and after to Rose, daughter of Sir Henry O'Neill, of Shane's Castle." He married the widow of George Villiers, Duke of Buckingham, in 1635, and in 1639 she induced him to

build the landward part of Dunluce, as nine of their servants went down with the ruins of the kitchen into the sea in that year. Lord Antrim was imprisoned as a Royalist in 1642 by General Munro, who *cessed* the estates for the support of himself and troops, in the same way as he had done in Belfast. It was not till 1666 that the Marquis regained possession by a new patent granted through King Charles II. His first wife died in 1649, and he was married to Rose O'Neill in 1653, who decorated, as tradition affirms, the ceiling of the old church at Dunluce with the various constellations in gold on a blue ground. On his return to the castle, the Marquis set about building a more modern residence at Ballymagarry, where the walled-in gardens already existed. As the country was now settled, he followed the example of Lord Arthur Chichester at Joymount, Carrickfergus, and erected a commodious mansion, without regard to fortification. In 1671, Oliver Plunket, Roman Catholic Archbishop of Armagh, wrote:—"I was with him for three days at his house at Dunluce; it is a noble building. The palace is perched on a high rock, which is lashed on every side by the sea." (Hill's "*MacDonnell's of Antrim.*") When the Marquis died at Ballymagarry, in 1683, he had another house at Glenarm, where the family afterwards spent more of their time, making the former a sort of summer residence. In 1750 a local paper contained this item of news:—"Last week the house of Ballymagarry, one of the fine seats of the Right Hon. the Earl of Antrim, was burnt to the ground by the carelessness of servants." The Ulster Miscellany, a very scarce work, printed in 1753, probably in Belfast, contains the following poem, entitled—

"*On the burning of* BALLIMAGARRY HOUSE, *the Seat of the Right Hon. the Earl of Antrim.*"

How is the antient ſeat destroy'd,
By heroes long, and long enjoy'd!
How have the flames destroy'd the pile,
Where love and plenty chose to ſmile.
Oh may the fabrick rise once more,
And flourish as in days of yore.

When Amphion would his Thebes surround,
His voice did chant, his harp did ſound;
Till the materials great and ſmall
Danc'd into form and built the wall.
Oh could my ſong have such effect,
I would myself be architect;
I'd make the best materials come,
Dance into form and build a dome:
That dome should be the Phœnix call'd,
Like that Arabian bird extol'd,
Who from a fierce conſuming flame
Aſſumes a new, and fairer frame.
The dome thus rais'd, there would I place,
Till time be done, the Antrim race,
That riſing ages might behold
The love and friendship of the old.

Bishop Pococke, in his Irish tour, 1752, recently edited by Rev. Dr. Stokes, thus mentions it:—"I took a walk also to Lord Antrim's house, close to Ballymagarry, which was burnt down about two years ago. It is a fine situation, commanding a view of the sea of Enishowen to the north-west and of the sea coast to the east. The house was built of the pillar stones of the quarry I have mentioned near, and I saw one of nine sides. Lord Antrim had thoughts of building a house on a spot near, but it is said has altered his purpose." We visited this historic site on the 29th July last, and were shown everything of interest by the intelligent tenant, Mr. Hugh Hunter. The plan of the place reminds one somewhat of a French chateau, as several wide avenues, walled on each side, and with massive circular gate piers, converge to a centre, occupied by the present farm house, which was built shortly after the fire. A part of the old office-houses remains, and bears traces of the conflagration. In the courtyard, between the house and garden, is a large stone trough, formerly supplied with water from higher ground a mile distant, brought in the curious pipes, one of which Mr. Hunter has presented to the Museum. A large space is occupied by walled-in gardens, containing very old apple and pear trees, hoary with lichens, but still bearing some fruit. The traces of a bowling-green on a raised terrace are plainly visible. Perhaps the most conspicuous of the buildings is the circular edifice, with massive

buttresses and steeply-pitched roof, covered with little slates, which tradition says was the barn, and once used for threshing. I am indebted to Mr. James Boyle, J.P., solicitor, the owner of Ballymacrea, an adjoining townland, for valuable information on the subject. He also informs me that many more houses formerly stood between the crossroads and the mansion, and the place was named on old maps of the district "The Townland of Ballymagarry." At Dunluce, as both Rev. G. Hill and Rev. J. O'Laverty, P.P., M.R.I.A., show in their histories, was a town, a token of which, issued by a merchant there, is sometimes met with. It may be of interest to add that local tradition says the water pipes already mentioned were made on the spot of a fine clay, laid over hay ropes, which were burnt out in the kiln. An examination of their interior shows this to be possible. They were made so as to fit one into the other. It is also told that the early hydraulic engineer who carried out the Ballymagarry water scheme was asked by the Marquis what his fee would be for the job. He replied, with unusual simplicity, that he only wished to have a set of the gilt buttons with the family crest which the livery servants wore. His request was granted.

I would here tender my best thanks to Miss Steen, Sharvagh, Bushmills, for the loan of so many fine specimens from her collection; also, my warmest thanks are due to Messrs. W. Swanston, J. Stelfox, and R. Welch for the many lantern slides so kindly lent for this occasion, and to Mr. John Wallace for the way in which he has so cleverly shown them.

This paper was illustrated by a large number of excellent photographic views, shown on a screen by limelight.

Professor FitzGerald—I wish to refer to one of the matters which Mr. Tate mentioned: the Conference of Delegates to the Society of the British Association. A large number of the photos exhibited were excellent specimens of some of the things particularly desired by that Conference. There is not a great deal that calls for remark in the other papers, except that we were very glad to find we were to have some natural history papers this Session. I was afraid we were going to get in for a

run of engineering papers. I must congratulate Mr. Praeger in having obtained so many rare plants, including one new to Ireland altogether.

Mr. Armstrong—I would like to ask Mr. Young if he can give me any information regarding the theory accounting for the peculiar formation of the rocks of the Causeway?

Mr. Young—Professor James Thompson's paper was quite conclusive. I am pretty sure I have copy of it, which I will be happy to place before Mr. Armstrong at any time.

4th January, 1893.

Mr. J. H. Greenhill, Mus. Bac., in the absence of the President (Professor Fitzgerald), occupied the chair.

William Gray, Esq., C.E., M.R.I.A., read a paper entitled

THE TRACES OF PRIMITIVE MAN IN THE NORTH OF IRELAND.

The Chairman said prior to the business paper of the evening being proceeded with he desired to refer to the death of Mr. Darragh, an old and respected officer of that Society. Mr. Darragh had acted for a great many years as curator there, and he thought it was right that a vote of condolence of the members with the late Mr. Darragh's relatives should be adopted on that occasion.

Mr. Robert Young, C.E., in moving a vote of condolence with the relatives of the late Mr. Darragh, said that much-respected gentleman had been appointed curator in the Museum in the year 1844. He was born in the year 1813, near Hillsborough, and came to Belfast as a boy. He had always been a great fowler, and through the influence of Mr. William Thompson, the Irish naturalist, who became aware of Mr. Darragh's zeal for natural history, he was appointed as curator of that Museum. Mr. Darragh had been offered an appointment by the Dublin Museum, but declined to leave Belfast. He was a most estimable officer of the Society for nearly half a century, and had done some admirable work for it during his long period of service.

Mr. Wm. Gray said it was a melancholy satisfaction to him to second the resolution which had been proposed by Mr.

Young. He had known Mr. Darragh ever since he came to Belfast, over thirty years ago, and had always found him a thoroughly efficient and courteous officer, always willing to give ready help to anyone interested in natural history.

The motion was passed in silence.

Mr. Gray said :—The question of man's antiquity in County Antrim and the North of Ireland cannot be considered apart from the general question of the antiquity of man in Ireland, and the question of the antiquity of man in Ireland cannot be considered unless in relation to the traces of primitive man in Europe. Our subject is speculative, because we have no history to guide us. The best way to get a proper idea or conception of the condition of primitive man is by comparison, and we should endeavour to compare the remains we have with similar remains found elsewhere. History and tradition fail altogether in throwing any light on the dark region to which I refer, and it is only when we come to bring the searchlights of archæology and geology and astronomy to bear on the subject that we discover something about the condition of mankind at that extremely remote period. We find he had reached a certain stage of civilisation, and moved from place to place following distinct lines of migration. The movements took two distinct directions—one to the east and the other to the west—and it was along those lines that we find the remains which give us an indication of the condition of mankind at that time. The point from which these waves of migration set out, or the period at which they commenced, are both obscure and indefinite, but it is in their tracks that man's works may be found which indicate his earliest steps towards progressive civilisation.

There were thrown upon the screen a series of original lime-light slides illustrative of the subject of the lecture, each of which Mr. Gray described in detail, all going to elucidate the primitive condition of man. Many of these were of glacial deposits, to be found both in the North of Ireland and in England and Continental countries, and also representations of

flint implements found in sand dunes and caverns, illustrations of cromlechs, sepulchral monuments and urns, lake dwellings, and human remains, and in each case continental examples were compared with what occurs in the North of Ireland. The slides were admirably exhibited on the screen by Mr. J. J. Andrew.

Mr. YOUNG—With regard to the sepulchral monuments that have been referred to, I think there is no doubt of what Dr. Petrie has written, that though these monuments are now bare and what are called cromlechs, originally they were meant to be covered with either clay or gravel and loose stones.

Mr. ALLWORTHY—I would like to ask Mr. Gray a question—We have found the bones of animals, but has it been clearly shown that we have the remains of man himself mixed with the other remains which are primitive ?

Mr. GREENHILL—I did not quite understand one point referred to by Mr. Gray—the connection between astronomy and primitive man. I am aware that the glacial age was one of the subjects taken up by Sir Robert Ball, but I do not see what astronomy has to do with the subject dealt with by Mr. Gray.

Mr. S. F. MILLIGAN, M.R.I.A., exhibited a very valuable collection of rare Irish and Mexican antiquities, recently found, and gave a brief and instructive explanation in reference to many of them.

Mr. ISAAC J. MURPHY read a Paper entitled

"THE DIVISION OF ANGLES AND ARCS OF CIRCLES."

I have entitled the paper, "On the division of angles and arcs of circles into aliquot parts," in which title there may seem to be tautology, for the division of an angle includes with it the division of the arc of the circle, actual or supposed, which subtends the angle, and *vice versa*. But practically in some

cases the division of the angle precedes the division of the arc; in other cases the arc is divided first, and then the division of the angle is derived from the division of the arc. For example, in one of those instruments of which I shall presently describe the operation, that for the trisection of an angle, it is the arc which is mechanically trisected by pointing off its third part on the circle; while another instrument which I shall describe, being for the construction of a particular triangle, must have its result applied to a circle, if the arc answering to its angles is to be divided.

Much attention was paid by the geometers to the trisection of angles. It is almost if not quite self-evident that the bisection of angles must have been very early practised, the operation being most simple, and the proof equally simple. It is probable that many generations of mathematicians were ignorant that the trisection of any angle, excepting always angle 90° and its half, quarter, &c., is impossible in plane geometry, and it is probable that after the impossibility of that operation was considered to be established, the analytical reason of this continued long to be unknown. Plane geometry admits only of the solution of problems, the algebraic equations whereof, under any algebraic alphabet, are expressible in equations of the second degree. An equation of the third degree is the symbol of and represents actually or by inference a solid, or something derived from a solid, and plane geometry does not take cognisance of more than two dimensions. The equation of a straight line in relation to the circle, and the converse equation of a circle in relation to a straight line, are of the second degree; the equations of all other except a limited number of lines—we may regard the circle as a line if we consider its circumference only—are of the third and higher degrees. It has come from this to be a maxim that in plane geometry no instruments are admissable for use except the rule and the compasses, which, however, is not a principle, but rather a result from the analytical reason I have spoken of. This leads me to observe, by way of parenthesis —for this is not directly associated with my proper subject—

that, although the compasses have been known from time immemorial as instruments which draw a circle with absolute theoretical accuracy, there has not been till within less than thirty years an instrument enabling us to draw a straight line with absolute theoretical accuracy. I believe it was in 1867 or 1868 that M. Paucellier invented what he calls his cell, which performs that operation, and which for the first time in the history of mechanics produces a perfect parallel motion, deriving in fact the straight line from the motion of two circles of different radii.

Not to dwell on this, however, and to return to the trisection of angles. While plane geometry proper admits only of those instruments which have for their correlatives the two lines of the second degree, there are thousands if not millions of problems solvable with the aid of other instruments, with the same theoretic accuracy as the problems of plane geometry and its trigonometrical branch. One of these is the trisection of an angle. Greek geometers—whether before or subsequent to Euclid I do not know, but after him I believe—had constructed a curve, which they called a conchoid, by the aid of which they were successful in trisecting arcs with as absolute accuracy as the imperfection of the drawing of the curve would allow. My instrument does the same. There is a solution of the problem given by Professor Casey in the appendix to his Euclid which, so well as I remember, is virtually the same in slightly different form. These processes divide the arc first, and the angle by the result; the equation derived from them is the same. Thus, let $A\,B\,C$ be a right-angled triangle, $B\,C$ or a the hypotenuse, $A\,C$ or b the base, and x the segment of b towards C, which subtends two-thirds of the angle at B on that side; then the equation is $x^3-3\,a^2\,x+2\,a^2\,b=0$; which is a cubic. Likewise, the value of the sine of three times an angle is $3\sin-4\sin^3$.

In addition to these processes, which are based on making the external segment of a secant (not a trigonometrical but an ordinary secant) meeting a diameter produced, equal to the radius, as on the board, there is another which is considered to

be much more ingenious. If in the hyperbola the transverse axis of which is to the conjugate axis as $1 : \sqrt{3}$, there be drawn lines from the focus, and from the extremity of the transverse axis beyond the centre from the focus, meeting at any point in the hyperbola, then the angle of the triangle so formed, which is at the focus, is double of the angle at the extremity of the axis; when, by drawing a line from the vertex parallel to the base, that line evidently trisects the external angle. I need not pause to give the demonstration of this, which may be either by the ordinary analysis by ordinates or, more simply, trigonometrically. The history of this solution of the problem is interesting. I was for the first time informed of the method while I was engaged in the construction of the instrnments on the table; and told that the author of it was a Danish astronomer, who published it in the astronomical transactions of 1868. But a short time afterwards I found the solution in a mathematical book of the early years of the century, which I found at a bookstall. The interest belonging to this method is chiefly that the angle is trisected without using a circle, and thus the division of the arc follows the division of the angle, instead of preceding it as in the method of any instrument. In the division of angles into other fractional parts, one-seventh, &c., no circle need be used; but in my instrument (that on the table), for the division of angles into fractional parts, it is the arc that I divide.

I now proceed to the demonstration of the proposition on which the working of my trisecting instrument depends. On examining the instrument, it will be perceived that the manner in which the parallelism between the two bars is ascertained is mechanical purely; and in this model the strength of the parts is not properly proportioned. The leverage, owing chiefly to the fineness of the screws (35 per in.), is so great that it overcomes the resistance which the passing of the pressing point from the end of the spring face that contains the spring to the other end, ought to give to working the machine any longer; the machine, in fact, ought to lock itself when the angle is trisected. The spring accordingly is plainly not strong enough

by a great deal, and I am obliged to verify the parallelism by the unsatisfactory way of mere observation. This defect is still greater practically in the other model, as I shall show when I arrive at it presently. But I need not point out that these mechanical imperfections do not affect the theoretical perfection of the instruments. The only angles which can be marked on the circle with absolute theoretic accuracy, are 45°, 36°, and 30°, with their halves, quarters, &c., and their integral multiples. 45° and 30° are derived from the circle itself, 36° from the triangle by which the pentagon is arrived at. There is no geometrical way of pointing off 20°, 10°, &c. When I arranged in my mind the details of my instrument for trisecting, I had done so with the hope that to be able to point off 20° would be of assistance in that extremely nice work, the division of the circles of telescopes. I showed my method to Sir Howard Grubb, who, while recommending me to patent the instrument, at the same time assured me that the present empirical division of the circle by the use of micrometers is so practically accurate that it would be impossible for any instrument, however theoretically exact, to enable that accuracy to be surpassed. He asked me how many screws I intended to connect the guilding bars with, and advised me to have five, not three, as I had thought of, and to have the screws of considerable fineness. 100 per inch—a screw of which pitch he showed me—would not be too fine. In working the instrument at first I found the strain greater than I had expected. Thinking that this might be owing to the pressure of one of the bars upon the outside of the groove of the circle—or perhaps I should say the pressure of the pivot or swivel on the groove—I added a carrying radius to keep the swivel always in the exact middle of the groove without pressure, since when I find the machine easier to work, and no increasing resistance, as there had been when the bar began to near the trisecting point.

Respecting the machine for dividing angles into fractional parts, it will be observed that the two sides of the semi-circle are set differently. I have one set at 45°, the other at 30°.

The idea of the instrument is based on this difference: the pointing radii are worked at different speeds in such way that when they have brought the end of the bar that starts at 30° at its proper speed and the end of the bar that starts at 45° at its proper and greater speed to exactly opposite points on the diameter, the fraction required is marked. Like as in the trisector, I ascertain the exact opposite points by the parallelism to the diameter by the use of a spring face; but the machine is worked by screws and gearing, and this method, though theoretically exact, is subject to mechanical errors, which deprive its actual results of anything like the correctness that I have succeeded in obtaining with the trisector. For example, to find one-fifth part of angle 45°, or any other angle, set the radius pointing to the angle, and set the other radius at 30°. Five-sixths of the angle proposed to be divided, that is, itself minus its sixth part, is the distance this radius must traverse; and 30°, minus five-sixths of the proposed angle, is the distance that the other radius must traverse. Place pinions in the axles that respectively work the radii, such as will give these speeds. (Here the lecturer went into some mechanical details of the instrument, and recommended that in no event should the screws ever be taken out.)

In this plan of dividing angles we divide the arc rather than the angle. But in the rough model of another instrument, which I now produce, there is no circle employed. The model is rather rough, having been made in some haste last week by a cabinet-maker who has some knowledge of mathematics. It is not for the division of angles in general, it is only for the division of the circumference of the circle into seven equal arcs; and other instruments, based on the same method as it is, could be constructed for the division of the circle into any odd number of equal arcs. Some of course are easier to make and simpler than others, which must have far more parts or bars than this. We can draw with theoretical correctness a square, an equilateral triangle, and a pentagon, with their integral multiples, regarding, as we may, the hexagon as a multiple of the equilateral

triangle. The pentagon is derived from an isosceles triangle, the angles at the base of which are double the angle at the vertex. That triangle contains, by drawing a line across it bisecting one of the base angles, two isosceles triangles, the smaller of which is similar to the whole ; it is composed of them in fact. The triangle which the instrument on the table is constructed to give, that is an isosceles triangle, each of the base angles of which is treble the vertical angle, consists also of two isosceles triangles. But, unlike the triangle of the pentagon, one of the triangles of which is similar to itself, the heptagonal triangle consists of two isosceles triangles, not similar to one another, and neither of them similar to the greater triangle. The nonagonal triangle consists of three isocles triangles, one of them similar to it. The undecagonal triangle consists of three isoceles triangles, part of one of whichs overlaps the another ; trimdecagonal triangle likewise. The non-adecagonal triangle consists of four, one of them overlapping another. The eistrincontial triangle, that the base angles of which are 15 times the vertical, consists of four exactly ; and all of the form the base angles of which are $2^n - 1$ times the vertical, consist of sets of isocles triangles without any over-lapping. It is to this that we owe the power of forming by a system of linkage, the idea of which is indicated by the model on the table, triangles of the order, angles at base n times angle at vertex, and by their aid we are accordingly able to divide the circle into $2n+1$ equal arcs. It is worth while for me to mention that when we draw these triangles with the lines dividing one of the base angles meeting the opposite side, the analogies of the sides, the dividing lines, and the segments of the side to which they are drawn are most interesting and extremely numerous.

Mr. Greenhill.—I did not know I was going to be called upon to make any remarks, but merely to express the thanks of the Council to Mr. Murphy for his very curious instruments. I think this building contains some extraordinary examples of skill ; but I venture to say that there are none more extra-

ordinary than those instruments on the table. I confess I am not able to judge as to what practical application could be made of them, and I think if they are intended to do away with the reasoning properties in the use of the compass and rule it would perhaps be a mistake to have Mr. Murphy's apparatus made applicable for scholastic purposes. From a mechanical point of view, I may mention one matter referred to, viz., the screws being considered extremely fine 35 to the inch. It may be interesting to know that I myself have cut in the lathe screws of 100 to the inch on steel bars 7 inches long by $\frac{3}{4}$ inch diameter. The first screw required 28 hours of close application. It was necessary to use a microscope to examine the thread; and when the tool was at all blunt, it has taken me as long as an hour and a half to insert the point of a re-sharpened tool into the thread already cut. I believe that threads of 250 to the inch have been cut at Mr. Edison's laboratory. I cannot at all profess to criticise the diagrams shown; but I am perfectly certain that I convey the mind of the Council of this Society in expressing to Mr. Murphy our sincere thanks for his very valuable gift.

Professor Everett having seconded the vote of thanks, mentioned that a Belfast schoolboy, A. A. Robb, a pupil of Mr. Nixon, had discovered a way of dividing a circle into seven equal parts. (See vol. 55 of the reprint of the *Educational Times.*) Prof. Everett then exhibited a linkwork of his own invention (a kind of lazy-tongs), which solved the problem of dividing an angle into any number of equal parts; and showed a drawing of another linkwork for the same purpose, invented by Professor Sylvester.

Professor Purser.—Mr. Murphy has touched upon the question of the possibility of the solution of certain problems in Geometry, and the impossibility of the solution of others. It is of interest to examine exactly what we mean by this. When the ancient mathematicians produced a problem insoluble by Plane Geometry they meant that the construction for solving it could not be effected by drawing right lines and

circles, in other words, by the use of a ruler and pair of compasses. For example, the trisection of an angle and the finding two mean proportionals are impossible problems in this sense. These and other like problems can be effected by the description of ellipses and by hyperbolas. Of course these are plane curves, but they were studied by the old geometers as the sections of a cone, and were considered by them therefore rather as belonging to solid geometry, and their use was regarded by them as inadmissible in what they called Plane Geometry. It is curious that the great mathematician Gauss proved that though we cannot divide the circumference of a circle into seven equal parts by a rule and compass, we can divide it into seventeen. I would only add that I have listened with great interest to Mr. Murphy's description of his beautiful instrument.

Mr. MURPHY thanked those present for the flattering way in which they had received his communication and expressed the pleasure it had given him to deliver his lecture.

7th February, 1893.

Professor Fitzgerald, B.A., M.I.C.E., President, in the Chair.

"AN ARTIFICIAL AGE: PORT, THE PATRON, AND THE PILLORY."

By Mr. F. Frankfort Moore.

The paper which I shall have the honour of offering to your notice this evening is a very desultory one. It will not aim at instructing you on any particular point with that definiteness and finality which mark a doctor's—a young doctor's—diagnosis of an intricate case, but I hope that it may help you to recall some agreeable pictures of which you may have caught glimpses in the works of many writers for whom the middle of the eighteenth century has had a certain fascination ; I can only hope that it may bring back to your minds some of the varied incidents connected with the social and artistic life in England about that period. In many cases it is only necessary that one should speak certain names to bring before our eyes a series of exquisite pictures. When the name of Addison is spoken there passes before us the stately retinue of which Sir Roger de Coverley was the leader ; when we speak of Sir Joshua Reynolds we stand in a moment in the centre of a group of gracious women, every one of them having an air of distinction, and men, every one of them with his character impressed upon his features. Within the brief space at my disposal it is only possible for me to speak in your hearing a few of the names that must be for ever associated with the art and literature of the period which may roughly be said to

be included between the years 1740 and 1780. I propose with your permission to draw for you a few sketches of the social life of that period, though I am not sure whether you will regard so desultory a treatment of the subject in the light of a lecture.

Some time ago there was a great sale of wine at a country house near Edinburgh. A small innkeeper was noticed buying all the odd lots, and the agent, wondering what he meant to do with them, took the opportunity to call with him a few days after. He found him engaged in mixing into one great vat the various odd lots—Imperial Tokay, Chateau Lafitte, Madeira, and Canary. "What do you mean to call that?" inquired the agent. "Well, sir," said the inkeeper, "I think I'll call it sherry, but I'm no sure." Ladies and gentlemen, these desultory sketches of mine—these odd lots of the last century—you may call a lecture—but I'm no sure. In referring to some of the leading influences of the period as Port, the Patron and the Pillory, I think I have not sacrificed accuracy for the sake of alliteration. Port, the Patron and the Pillory played a large part in the social, and I fear it must at once be confessed, the artistic, and even—and this is worst of all—the literary life of the eighteenth century. In what proportion the first two elements accelerated the influence of the third I do not venture to say. Port was a power in those days. Where it all came from is as great a mystery as where all the champagne comes from nowadays. I am strongly inclined to believe that most of the old wine drinkers might have had the melancholy satisfaction of feeling that they were encouraging a home manufacture. I will not do our modern exponents of the science—or is it an art?—of producing a really high-class, fully matured wine out of a handful of chemicals, the injustice of asserting that their superiors in this direction existed in the eighteenth century; but I venture to think that chemicals played a less important part than the common or garden gooseberry in the manufacture of the wines that were generally drunk a hundred and fifty years ago. If it had been otherwise, the English race

would have perished off the face of the earth. No ordinary step could be taken in life without a bottle of port. A serious step demanded a second, and sometimes a third; after the third—well, I am inclined to think that the gravity of the situation was not appreciably diminished. I have often wondered if they knew anything about the racking of whisky. The subject is not a pleasant one to dwell upon. I will only give you one instance of the important part played by the "bottle of wine" in the daily life of the period. Of course, it was only to be expected that Goldsmith, when unfortunate enough to be arrested for debt at the instance of the person who was unfortunate enough to be his landlady, should send out for a bottle of wine until Dr. Johnson—who, by the way, told the story—arrived to unearth the "Vicar of Wakefield;" but what about Dr. Johnson himself? You are all familiar with Carlyle's references to Dr. Johnson as "our real Primate"—"the true spiritual edifier and soul's teacher of all England." Well, here is one of Johnson's "reminiscences":—"I remember writing to Richardson from a sponging-house, and was so sure of my deliverance through his kindness and liberality that before his reply was brought I knew I could afford to joke with the rascal who had me in custody, and did so over a pint of adulterated wine, for which at that moment I had no money to pay." Now, there, in Mr. Birrell's words, we have the true warm-hearted literary tradition of the eighteenth century. It is very amusing; it is full of good feeling and fellowship, but the morality of the transaction from the great moralist's point of view is surely, like his linens, a trifle dingy. The soul's teacher of all England laid by the heels in a sponging-house and cracking jokes with a sheriff's officer over a pint of wine on a chance of another man paying for it, is a situation which calls for explanation. To anyone acquainted with the period I think it requires no explanation. "Spiritual edifiers and souls' teachers" had no qualms about cracking a bottle of port—let us hope the qualms came later.

The Patron of the period was not invariably the detestable

character which he is made out—mostly by literary men—to be. So far as I can gather he was just a little too liberal with his guineas to the miserable rhymsters who haunted his ante-chamber—when they got so far. The patron paid handsomely for the very doubtful privilege of having dedicated to him what was called a copy of verses. The verses were rightly so called. They were copied verses—that is, the best of them. The others—those that were original—were not merely unrythmical, they were unspeakable. You know what an unmacadamised road is. Well, if you read some of the verses that the patrons patronised you will find the literary equivalent to the unmacadamised road. Without the patron the poet would not have been. Ladies and gentlemen, the patron had a great deal to answer for. Dr. Johnson sought his patron, but failed to find him, and so failing, turned upon him and rent him in one of the most perfect specimens of complete letter writing that exists in literature. The one man who had sufficient self-respect—sufficient self-reliance—sufficient independence to publish his first poem without a patron was an Irishman. His name was Oliver Goldsmith. His poem, "The Traveller," was dedicated to his brother. "The Deserted Village" was dedicated to his dear friend Reynolds. And now that I have mentioned the name of Goldsmith, allow me to say that the extraordinary ideas that have prevailed regarding him for many years are in my opinion due to the unfortunate circumstance of his being alluded to so frequently by a person named Boswell—a Scotchman upon whom the proverbial surgical operation had not been performed. Boswell never understood to the day of his death that Goldsmith was laughing at him. Perhaps, too, Boswell may have heard what Goldsmith said of him, when someone asked "Who is that cur that follows Johnson about?" "He is not a cur," said Goldsmith; "he is only a burr. Kelly threw him at Johnson one day as a joke, but he has stuck to him ever since." This was probably the one jest of Goldsmith's that Boswell could understand least of all. Another misfortune of Goldsmith's lay in the circumstance that Noll

rhymed with Poll, and Garrick knew it. How many generations have judged Goldsmith solely on the evidence of Garrick —evidence wholly dependent upon the exigencies of rhyme— "for shortness call Noll, who wrote like an angel and talked like poor Poll!" Like poor Poll! The man who described the character of Boswell in four words talked like poor Poll! When Johnson declared in that fine free style of his, the defect of which was certainly not a lack of decision, that it was quite easy to write a fable, Goldsmith said, "You couldn't write one, sir, for if you introduced fishes conversing, you would make the minnows speak like whales." If this is talking like poor Poll, all I can say is that poor Poll was the most brilliant conversationalist of the century. What a pity it is that Goldsmith's name was not, let us say, Christopher. In that case the exigencies of the rhyme would have forced Garrick to write

> "For shortness called Kit,
> Who wrote like an angel and talked like a wit."

On the pillory of the period I do not care to dwell. But when I think of that great Englishman—the first great journalist that lived in England—when I think of Daniel Defoe standing in the pillory I feel, ladies and gentlemen, and I trust that you will share the feeling, not that De Foe was degraded, but that the pillory was glorified. They ordered the journalist's ears to be clipped in those days. Ladies and gentlemen, I think the ears of those who condemned them must have been a good deal longer than those of the journalist's, and consequently, offering larger scope to the shearers. They don't crop the journalists' ears nowadays. If the practice still prevailed, I am inclined to think that the fashion of wearing long hair down the side of the head would become very popular among journalists. A good many people would like to have a snip at them.

The lecturer then proceeded to describe the artificial society of the middle of the last century, referring to the beaux and the belles, subsequently dealing with the literature, science, and art of the period. In conclusion, he said—It would be im-

possible for me to bring to a close this desultory paper without asking your attention to the extraordinary change that has taken place in respect of that form of mysticfication known as oratory. There were great orators, we are given to understand, at every period during the eighteenth century. So far as we can gather, their finest outbursts were addressed chiefly to such abstractions as Liberty, Truth, Justice, nymphs, and negroes. The orators could never have made any progress without their mountain nymphs, and the negro, as an abstract quality called for some impassioned rhetoric. The negro in the concrete has usually been the object of a good deal of impassioned rhetoric. The orator now and again resorted to auxiliaries which in these days would scarcely be called legitimate. You remember how Burke, rising to a point of sublimity in one speech, took a dagger out of his pocket and flung it down upon the floor of Westminster Hall. That was a fine stroke of oratory. I have often wondered if he sent round for that dagger the next day, or if it became the perquisite of the hallkeeper. We have changed all this. Where would we be if Mr. Balfour were to give point to his argument in the House of Commons by flinging down a golf putter at the feet of Mr. Gladstone —if Mr. Gladstone were to produce from under the tails of his coat his celebrated axe—if Mr. Timotheus Healy were to dash a symbolic message of peace in the form of a blackthorn in front of Colonel Saunderson? It was my good fortune to be present in the gallery of the House of Commons when Dr. Kenealy made a speech that called for a great deal of laughter. "Laugh on, laugh on," cried that orator, "I shake ye off as the lion of the desert shakes the dewdrops from his mane." Now, there was a sample of the genuine, warm-hearted oratorical tradition of the eighteenth century, and the House was convulsed for several minutes. "How about that mane?" was the question that greeted Dr. Kenealy at any time he rose again. Some years afterwards I heard in the same building a true nineteenth century speech that was greeted by cheers and cheers, and that caused the occupants of the

Treasury benches to turn pale. This modern orator said, "Mr. Speaker, the right honourable gentleman who has just sat down made a speech that reminds me of the story of the man who was asked what he thought of a temperance lecture that he had been attending. 'It was a great success,' said he, 'until the lecturer poured himself out a glass of water, and then with a far-away look in his blue eyes mechanically blew the froth off the top of it.' Now, sir, the right honourable gentleman gave himself away at the close of his speech, like this lecturer. He tried to blow the froth of his glass of water." That, ladies and gentlemen, was the anecdote that nearly turned out a strong Government a few years ago. It indicates pretty clearly, I think, that in oratory as well as in other matters our ideas have greatly changed from those of our forefathers in that period of the last century which, I trust you will agree with me in thinking, included much that was tasteful, much that was cultured, much that was good, although among its characteristics were port, the patron and the pillory.

Professor MacMullan—A very pleasant duty devolves on me, namely, to propose a hearty vote of thanks to Mr. Moore for his interesting lecture. The lecturer has contrived to compress into a very short space a large amount of information in regard to the eighteenth century; and his criticisms are sound as well as brilliant. I beg to conclude by formally proposing a vote of thanks to Mr. Moore.

Dr. Sheldon—I think we shall all agree with the lecturer in regarding Defoe and Goldsmith as among the most prominent of our literary men. Goldsmith is a man who has never been esteemed as fully as he ought. I do not think anyone who professes to be a novel reader can justify his claim unless he has read the Vicar of Wakefield. As to Defoe, none of us who care for religious and public liberty can ever think of that man without feeling a grateful reverence for his memory, on account of his sturdy opposition to all political and religious tyranny. One other name was mentioned which illustrates the fact that though polish is desirable, it is by no means essential

—I mean Dr. Johnson. We remember him as the man who came forward and throwing off the patronage of the great appealed to the public verdict, and set literature once and for ever on a firm basis. It was he who showed that there is nothing disgraceful in seeking from the public a living by literature. After all, very much of the eighteenth century may be found in the nineteenth only under other forms, though we have in very many things improved. I have pleasure in bearing out what Prof. MacMullan has stated with regard to the lecture this evening, and in seconding the vote of thanks to Mr. Moore.

Mr. Moore.—The gratification afforded by your kind reception of my paper is largely increased by the very flattering remarks made by Prof. MacMullan and Dr. Sheldon. Being aware of the critical capacity of these gentlemen, you can quite understand that any remarks from them would be of genuine value. I came ready to claim indulgence for my deficiencies. Though I have written thirty-two volumes now, this is my first appearance on the lecture platform. Therefore you will see that I looked upon the First Offenders' Act as being particularly applicable to my case. Thanks, however, to the clemency of my judges I have no occasion to put forward that plea. If your Secretary is good enongh to honour me with an invitation to deliver another lecture at any future time, I trust I shall be able to bring before you something more worthy of your acceptance.

17*th February*, 1893.

Professor M. F. Fitzgerald, B.A., M.I.C.E., President, in the Chair.

"HISTORIC ULSTER."

By Miss Milligan, Member of the Royal Society of Antiquaries of Ireland.

In preparing my paper I have put together a plain narrative of the principal events of history, which will serve as links to connect the Ulster of to-day with the remote past. It has been assumed that the audience will be made up of two classes—the very learned, and, it may be said without offence, the very ignorant. The ignorance which I impute to a section of the audience is, of course, only in one department of knowledge. In the excellent schools of Belfast and its flourishing college every branch of science and literature is taught, but no provision is made for teaching the youth of Ulster the past history of their famous province. In spite of this deficiency in the scholastic and college curriculum, there has always been a goodly number of cultured, and it may be added, patriotic persons in Belfast, who are not content to remain in the state of ignorance to which their education has doomed them. The existence of this intellectual inner circle is shown by the splendid collection of books on Irish history which has been brought together gradually and with discrimination during a period of over a century in our local library. The reference is not, of course, to the uncatalogued collection in the Royal Avenue establishment, but to that in the Linenhall Library. There is in any case no excuse for any intelligent person remaining contentedly ignorant on this important subject, and I shall

address myself not to the learned members of the Philosophical Society, but rather to those who, having just finished their education, have the study of Irish history an untrodden path still before them. I shall lay down a sort of plan of study, and mention the books which may most profitably be read ; most of these, however expensive and rare, are within the reach of all in the excellent collection which I have mentioned. It is quite possible that many Ulster people have no desire for any acquaintance with the past history of the province in which they live. They perhaps glory in proclaiming that they are Scots of Ulster, believing that as descendants of seventeenth century planters they have no more connection with the ancient Irish race than the people of the United States have with the Red Indians. The position of anyone who cherishes this fallacy is to be pitied. The greatest of Irish poets, Sir Samuel Ferguson, has described

> " A rootless colonist of alien earth,
> A stranger to the land that gave him birth,
> The land a stranger to itself and him."

The mere colonist to whom patriotism is impossible is to be pitied ; how much more so the Scotch colonists in Ulster who talk as if they were aliens here. It is as if Israel after her years of exile would return to Zion and call her a foreign land. The Scots had gone forth from Ireland, from Ulster in fact, and returning here after many years they need not assume the bearing of strangers towards a conquered race. They have every right to share in the glory of ancient Ulla, every reason to wish to study the story of her greatness.

The pre-eminence of Ulster over all the provinces of Ireland did not begin with the plantation, but traditions that cling round the pre-historic monuments of the land show that before recorded time the North was the habitation of the dominant race. I shall not go beyond the traditionary coming of the Scots or Milesians, an event ascribed to the 1000th century B.C. The land is then said to have been divided between Irian, Eremonian, and Eberian tribes. The Eberian or Southern

tribes were reduced to a subordinate position. The Eremonians inhabited the East and West centre of the land, the Irians of the North their kingdom early called Ulla, and the fate of their ruling tribe, the great Clan Rory supplies the most interesting traditions furnished by the pre-Christian period. The name of Ulla stood at first for a territory co-extensive with Ireland north of the Boyne and Erne. Aedh Roe, the great ancestor of the Clan Rory, was said to have been drowned in the fall of the Erne at Ballyshannon. To his daughter Macha, at the year 400 B.C. was ascribed the building of a fort called Emania, the capital of Ulla, the great Kingdom of the North, whose kings of the Clan Rory line rivalled the kings of Tara for seven hundred years. The fact deserves to be emphasised, that though there may not be much truth in the early traditions of Ulla, yet the existence of that great kingdom and its capital at the beginning of the historic period is an undoubted fact, and the existence of traditions, however unreliable, shows at least that even at that time Ulla was considered ancient and re nowned. Before the Saxons left their motherland to settle in the island of Britain, hundreds of years before the English nation or the English language existed, Emania was the seat, and Ulla the kingdom, of a line of chiefs and heroes, whose existence is undoubted, though their name and fame have no other records than their unlettered monuments which tell too little, and the bardic tales which tell too much, for the strict purposes of historical investigation.

Referring to the literary cycle of tales connected with the kingdom of Ulla at the period of the reign of Connor MacNessa, who is said to have been contemporary with the Christian era. I recommend as a delightful guide to this period of Ullas' greatest traditionary glory, the history by Standish O'Grady. In this work all the traditions are set in order and linked into an entrancing tale, which on its narrative merits may compare with that of "Pelops' line, or the tale of Troy divine." The poems of Sir Samuel Ferguson will also be found invaluable in studying the history of ancient Ulla. "Deirdic, the Naming

of Cuchullin," and Aubrey de Vere's "Foray of Queen Meave," if read in the order named, will give the substance of the bardic tales in modern poetic form.

Of great interest also is the lost epic of Ireland, the Tain-bo Colney. The original composition had been lost when in the 12th century the substance of the poem was written down in prose form with occasional verse passages, in a MS. which is preserved in the Royal Irish Academy. The subject of the Tain was the invasion of Ulster by Meave, the Queen of Connaught, at a period when the warriors of Ulster had fallen under a magic spell, which prevented their defending the province. King Connor MacNessa and his band of Red Branch chivalry remained in a state of semi-insanity, unconscious of approaching danger in the palace at Emania, and when the invading host came to the ford of the Boyne one man alone barred their path. This was the youngest of the knights, Cuchullin, the impersonation of boyish valour and patriotism. King Connor had been guilty of a great treachery, which was, indeed, the cause of Queen Meave's invasion, but Cuchullin, though he blamed the King's crime, knew that the safety of Ulla depended on his own loyalty. He made a compact with Queen Meave, that not till he was slain would the invading host cross the Boyne into the Northern province. She sent the greatest champions against him, and one by one they were overthrown. She bribed Fardia, his dearest friend, to challenge him, thinking Cuchullin would refuse the combat, but for the sake of Ulla he slew his friend. The knights at length awoke from their stupor and came down from Emania, and the story ends with the total route of the Western host. The banner of Ulla, the Red Hand on a white ground, was the symbol which on this occasion "led the Red Branch Knights to danger." The death of Cuchullin, which occurred in a later war, was worthy of Ulster's representative hero. He was fatally wounded in a great battle in the County of Louth whilst repelling the invaders, and tying himself to a tall pillar-stone that he might die standing, he sent his charioteer to Emania with his last

message—"Tell the King that I guarded the border of Ulla until I was slain." No country in the world can boast of a nobler typical hero than Cuchullin, and even though he should be, like King Arthur, a myth, he is for us an example of the ideal cherished by our pagan ancestors.

The Clan Rory dynasty ruled Emania till the year 331, when it was supplanted by the Kings of the Clan Niall line, descendants of Con-Hundred-Battle, Cormac M'Art, and Nial of the Nine Hostages, who reigned at Tara early in the Christian era. The constitution framed by Cormac MacArt was probably in substance that adopted by Saint Patriek and by his successors set forth in the Book of Rights. The greatness of these kings, Con, Cormac, and Niall explained the fact that their descendants of the Clan Niall line were elected to the dignity of the Ard-righship, almost without interruption, from the time of Saint Patrick till the 11th century, when their supremacy was overthrown by King Brian Borou.

Without dwelling on the mission of Saint Patrick, I merely emphasise the facts of his connection with the North, and point out that he established the centre of Christianity at Armagh. The Northern part of Ireland was at the time of his coming divided into seven kingdoms. One of these, a greatly diminished territory, was Ulla, ruled over by Kings of the Clan Rory line from their new capital Rath Keltar, the present Downpatrick. The territory of Ulla was now co-extensive only with Down and South Antrim, and in the year 634 an attempt to regain their former dominions under Congal resulted in the defeat at Moyrath, and the kings of Ulla lost Southern Down, and made Rathmore their new capital. Their kingdom was sometimes called Dal-a-radia, not to be confounded with the neighbouring kingdom of Dalriada or North Antrim. The misfortunes of the Clan Rory did not end with the loss of Downpatrick in the seventh century, for as late as the fourteenth their powerful rivals the O'Neills seized the district now known as Clandeboye. I dwell on these details, as they are of local interest; in the remainder of the paper I shall deal with the fortunes of the great Clan Nial.

This clan had come from the West. The men of Connaught perpetuated in its name their great ancestor Con-Hundred-Battle. After the fall of Emania, the sons of Nial seized territory North and South of Lough Erne. Conal founded Tir-Conal, the present Donegal. Owen founded Tir-Owen, and the descendants of Colman, sometimes called the South Clan Nial, later on founded Meath. The Tir-Owen branch chiefly gave kings to the throne of Tara. It had been the custom for the head king when elected to go to reside there and preside over the administration of the laws and the triennial assembly of Parliament; but in the middle of the 6th century Tara fell under a curse, and each ardrigh, or chief king, made his territorial seat the chief palace of Ireland on his accession. As the great majority of the Irish kings came of the Tir-Owen branch of the Clan Nial, their seat at Grinian Aileach, near Derry, was the central point of interest till the fall of the Northern dynasty at the accession of Brian Borou.

The striking position of Grinian Aileach and the beauty of the scenery around Lough Swilly and Lough Foyle to be seen from that historic spot are remarkable. Passing now to the history of St. Columb, the founder of Iona and apostle of Scotland; the saint was born in County Donegal, and was of Royal lineage. Having been the cause of a great battle between his kindred and the supreme monarch, he withdrew from Ireland repentant for having brought about dissension in his native land, and undertook the Christianising of the Ulster colony of Scots, who had gone in the third century to the neighbouring country, afterwards called from them by the name of Scotland. The saint vowed never to look on Ireland again, and when an urgent call brought him to that country he is said to have kept his vow by coming blindfold. The occasion of his visit was an assembly called together by King Hugh at Dromketh, near Limavady, where by St. Columb's influence the Scottish colony was freed from taxation, and the bardic order was spared from suppression, which the King had threatened.

There are two poems ascribed to St. Columb. In the first

his departure into exile is described, and expressions of intense love for Derry, his "little oakwood," and sorrow at parting gradually give place to admiration at the beautiful shores of Lough Foyle and "the salt main where seagulls cry." In the second poem, which tells of his visit when blindfold, there is not one descriptive line. The saint could not see the shores as he passed, nor the trees and hills of Erin when he landed. The poem alludes only to sounds—"the cries of gulls in hosts," the wind harping on the elms, the lowing of cattle, the notes of cuckoo and blackbird. The poem, if not the saint's own composition, is perfect in expression and true to the circumstances it dealt with.

The southern Clan Nial kings of Meath made an arrangement with their kindred of the Tir-Owen line about the time of the coming of the Danes, according to which Meath and Tir-Owen alternately held the sovereignty of the land. It has been shown that these kings did their duty against the invaders. Brian Borou was not the land's only defender; his fame had been too long allowed to overshadow the greatness of his predecessors of the Northern dynasty. Flan of the Shannon, in the beginning of the tenth century, was especially remarkable for his energy and foresight. His daughter Gormley, a poetess, was married to Nial Glondu, of Aileach, who fell in battle against the Dublin Danes. This Nial was the grandfather of the first O'Neil.

Quotations from a poem describe how Murtagh, son of Nial, choosing a thousand leather-coated heroes, made a circuit of all Ireland to collect tribute and hostages. These hostages, kings or sons of kings, were kept in Aileach and entertained as if they had been clerics, till Murtagh brought them to the palace of Donogh, the ardrigh, for he himself was only heir-apparent at this time. Murtagh never succeeded to the throne, for he fell, as his father had done, in battle against the Danes. The last undisputed Clan Nial Ardrigh was Malachi of Meath, who in spite of his military talent, which had enabled him to hold the Danes in check, was unable to oppose Brian, King of

Thomond, who in the year 1001 laid claim to the crown. That an ardrigh should come from the South was quite unusual, for, though the monarchy was elective in theory, the northern dynasty had long monopolised it. Some called Brian a usurper, and it can not be denied that his overthrow of the Clan Nial led to anarchy, and ultimately to the English conquest; but he could not be expected to foresee the future, and he had received insults at the hand of Malachi. The circumstances which attended the fall of the Clan Nial were as follows. King Brian encamped at Tara, and gave Malachi a definite period in which to decide whether he would abdicate or fight for the throne. Malachi decided to fight if Hugh of Aileach, the head of the Clan Nial, would assist him. A bard was the ambassador to Aileach. Malachi had empowered him to offer Hugh the crown if he would lead against Brian, and the King of Aileach was inclined to accept, but could not do so without the approval of the tribal council. This assembly being called together, decided that on account of the danger of an encounter with the unconquered Dalcassian army of Brian, they would claim from Malachi not only the crown of Ireland for Hugh, but half the land of Meath for the Tirowen tribes. Malachi departed in a rage, and by advice of the Meathan tribal assembly made peace with Brian, and was loyal to him till the fatal day of Clontarf. The death of Brian Borou was followed by the second reign of Malachi, and then the country fell into a state of anarchy, which continued till the coming of the English.

The O'Neills resisted the English for hundreds of years. Brian O'Neill, who fell in 1260, was the last king of the name, and his son Donal of Dungannon was connected with the attempt to place Edward Bruce on the throne of Ireland. We may now refer briefly to the rebellions in Elizabeth's reign of Shane O'Neill and the more worthy and heroic Hugh, victor of the Blackwater. His long-continued struggle in partnership with Hugh Roe O'Donnel against English oppression did not end till he had wrung from the victors an honourable peace on favourable terms; but the English king, James I., had no

intention of leaving Hugh O'Neill in the position of authority which the treaty secured for him. Hugh became secretly informed of a conspiracy that was being hatched against him with a view to confiscating his lands. He determined to anticipate the designs of his foes, and in 1607 sailed from Rathmullan, on Lough Swilly, with all his kin and the new chief of Tirconal. This event, known as the Flight of the Earls, was followed by the confiscation of their lands and the Plantation of Ulster.

Passing on now to the massacre of 1641 and the war which followed, we note that affairs in Ireland at this period were complicated by the fact that the English were divided by the great civil war then raging. The contemporary history of that period may be studied more fully than any other, as all the important documents concerning it have been edited by the Librarian of the Royal Irish Academy, Mr. Gilbert. This publication may be seen in the Linen Hall Library. The generalship of the Ulster army was undertaken in 1642 by the greatest and last of the O'Neills, the heroic Owen Roe, victor of Benburb. As a child he had left Ireland with Hugh O'Neill, and had served in the Spanish army ; but returned to fight the battles of his country. His death occurring immediately before Cromwell's campaign, left Ireland without a defender. His son Henry was defeated near the shores of Lough Swilly, and executed at Derry by the Puritan leader Coote, who on a former occasion, when the Ulster army joined with the Parliament forces against Ormonde, had fawned on the noble son of Owen Roe, calling him always "his own sweet brother Harry." With the deaths of Owen Roe and his son Henry the history of the Clan O'Neill ended. Chiefs of this line had ruled the land for seven hundred years, and had for six centuries defied English rule. They perished at last, but their fate reminds us of Cuchullin, the guardian of our frontier, who died standing. It may be said of the O'Neill line of chieftains, "They guarded the borders of Ulla until they were slain."

The history of Ulster from this period is no longer concerned

with the fortunes of any Royal or noble house, but it is not less interesting. At Derry and at Enniskillen the new planters proved effectually that they had come to stay. Belfast first attracted notice in the year 1649, when no less a person than John Milton wrote in a State paper of the inhabitants at Belfast as a generation of Highland thieves and red shanks, who from a ground not their own dare send defiance to the sovereign magistracy of England. England had not heard the last of Belfast. In that town the Society of United Irishmen was founded, and in the rising in '98 a Belfastman died on the scaffold for the cause of religious liberty. Henry Joy M'Cracken and his colleagues might be honoured in their native town even by those who were most opposed to revolutionary methods. It was not as mere political malcontents they took the field, but as opponents of the hateful penal system which in spite of the Revolution of 1688 had oppressed Presbyterians as well as Roman Catholics. At Derry and the Boyne the ascendancy of one Protestant creed was assured, but in '98 the Presbyterians of Belfast were champions not only for liberty of their own Church, but for that to which they were most opposed in doctrine. Reading the history of the Ulster planters in this light, they showed themselves worthy descendants of the Scots of Ulster, who had left their motherland so many hundred years ago. They had never been far away, and they had returned to unite their fortunes with those of Ireland, as dwellers in the greatest and most prosperous of the provinces.

I shall conclude with an allusion to an old legend which tells how when St. Patrick preached at Tara a vision of the Knights of the Red Branch appeared before him. Prominent among them was a hero in a chariot. The saint demanded his name, and the answer might be taken as expressing the proud position of Ulster, for this phantom was her guardian genius, Cuchullin —"I am he that was called the hound of Ulla. I was not a hound for herding cattle, but for the guarding of the borders of territories, the defence of nations."

Mr. W. H. Patterson—We have all listened with great interest to Miss Milligen's very able paper. She has carried

out a most difficult task in dealing with so many subjects in the course of her lecture. It would be impossible to follow her through the vast range of subjects dealt with, and at this advanced hour I think I must content myself with moving that the best thanks of this meeting be given to her for the very able manner in which she has placed before us the details of some of the most interesting events in Irish history.

Rev. JAMES O'LAVERTY—I was extremely delighted with the beautiful lecture which we have just heard. I perceive that Miss Milligan is like everyone else who has a poetic mind and has studied Irish history—they invariably become very much prejudiced in favour of the Irish. An extremely interesting characteristic of the race was pointed out—that we never seem to forget what is past, an old battle or a defeat of a thousand years is but as yesterday. In the year 332, I think, the Heremonian race destroyed the old palace, near Armagh, of the Irian Kings of Ulster, and for ever ruined the power of that ancient Ulster race. In 1014 the battle of Clontarf was fought under a king who had superseded the Heremonian race in the sovereignty of Ireland. Amongst the army fighting against the invaders there was not a single Ulsterman of the Heremonian race, which then occupied four-fifths of the province, while amongst the most ardent supporters of King Brian were the Ulidians—the old Irian race of Ulster who came to support the man who had overturned the sovereignty of the race, which had seven hundred years before inflicted irreparable ruin on their Irian forefathers. Still later, at the battle of Downpatrick, in 1260, when the Tyrone men of the Heremonian race attempted to besiege Downpatrick and to drive the English out of it, there was not a single MacCartan or Magennis hero to join with the Tyrone men. The traditions of their race had so indelibly fixed in their memory the fall of Emania that nine and a half centuries could not erase it. This is a strange page in Irish history. We blame parents for not having their children taught Irish history, but it is also to be lamented that they are not taught to look back at things that have passed without being prejudiced on either side.

7th March, 1893.

PROFESSOR FITZGERALD, B.A., M.I.C.E., President, in the Chair.

"EDUCATION : A CRITICAL EXAMINATION OF THE THEORY AND PRACTICE OF DR. ARNOLD, OF RUGBY."

By Dr. SHELDON.

DR. SHELDON introduced his subject by a sketch of Dr. Arnold's life and work, in which he traced the influence of Dr. Arnold's thought and character upon his teaching and his pupils, and indeed on education in this country. The lecture was divided under three main heads—Arnold's teaching maxims, his discipline, and his moral force. In connection with the first of these heads he showed that there was no belief more firmly rooted in Arnold's mind than that all education should have Christianity as its base. He maintained that a moral cannot be separated from a religious education, unless people have the old superstitious notion of religion, either that it relates to rites and ceremonies or to certain abstract and unpractical truths. He did not approve of sending boys to large private schools of more than thirty boys, neither did he approve of sending children under twelve to boarding schools. The chief end of education he regarded as the development of the mind rather than the acquisition of facts ; not knowledge, but rather the means of acquiring knowledge. Arnold's notions with regard to useful education were next discussed ; and the lecturer sketched at length his views on discipline, including caning, removal of boys, and so forth. He concluded by dealing with

the moral force and influence of Dr. Arnold, expressing the opinion that in proportion to the period over which his work extended Arnold had succeeded in his objects.

Mr. Foster—We have all listened attentively to the lecturer in his admirable account of Dr. Arnold's work. Dr. Arnold said that he had a great objection to large private schools. I know boys who have gone to large private schools in England, and they certainly have not received any adequate return for the money spent. As regards sending boys abroad, the same experience holds. I really believe it is a waste of time for junior boys to be sent abroad for the purpose of acquiring a smattering of conversation in languages. They come back here and have to learn the grammar over again. I do not altogether agree with Dr. Sheldon regarding what he called useful knowledge. Since Dr. Arnold's time there has been great progress in physical science, and there can be no question that a boy can get as good a training in physical science as he can under the old system of devoting three-fourths of his time to learning Greek and Latin grammar. In reference to the hearing of lessons by questions, I believe that system has been unfairly criticised by parents. I have often heard it said that they would wish to exchange places with the master, and let the master teach the boy and the parent ask the questions. They would probably lead to unanswerable difficulties. I quite agree with Dr. Sheldon on the subject of the caning of boys. I think a little caning is not amiss sometimes. It is a punishment which I do not care for inflicting myself, but I think it a useful deterrant for small boys; and as regards the degradation of it, if you ask the boy his choice whether he will stay in for an hour or have a little summary chastisement, I think I could guess his answer. I quite concur with all that has been said about governing schools by boys themselves; but I do not agree with the "fagging" system, or the power given to senior boys of inflicting punishment. I think that should be left to the masters themselves. Dr. Arnold's success has been twofold. In his own school he raised the moral tone very much, and he

also brought in a system and method which have greatly improved the tone of all the schools in England. The number of his pupils who have distinguished themselves in after life may not appear large, but that is accounted for by the fact that he died at a very early age. His whole time at Rugby was only about ten years, but in the universities it began to be recognised that boys who came from Arnold's school had a very high moral tone, and in that way his influence was very great.

Dr. Calwell—Anything coming from Dr. Arnold commands great sympathy and reverence, but it would require a considerable time to criticise a paper on this subject, which Dr. Sheldon has made so peculiarly his own. I have not that time, so I am afraid any remarks I may make will hardly partake of the nature of criticism. There is considerable difficulty in discussing a question of education. One is very apt to move off in an orbit of one's own, and, forsaking the paper, to give his own peculiar views about education. I was very glad to hear Dr. Sheldon lay so much stress on the necessity of having a clear idea of what we hear called useful knowledge—viz., the elementary parts of the general education. My own opinion is that science trains much more deeply than does the ordinary method of learning the classics. We gain a great deal in training the powers of observation by studying such a science as botany, and we actually gain moral training by studying such a science as astronomy. The system of training by asking questions is, in my opinipn, an admirable one. From what experience of teaching I have, I know that it is certainly the best way of making the hearer gain an intelligent idea of the subject. Coming to my own system of education, I would put it as follows. You can divide the education of a boy or girl into two periods. The first is that of school, where he is taught the necessaries of ordinary civilisation. How far you should go beyond that in teaching him the sciences—political economy and so on—depends greatly on his age, ability, and future prospects in life. The second period begins after he has

left school. If he goes to college his course is fixed; but suppose he goes to business, then I think it should, as it is, become, and it is becoming, the custom to take up a study either half yearly or yearly, and to continue this practice far on into life. It is utterly impossible that a schoolboy should master the number of languages that are sometimes popularly taught, or the different sciences. They may be taught the elements of some of these, but it is beyond the function of any boy's brain to master, say, five languages, a number of sciences, as well as mathematics, chemistry, and so on. This should not be attempted; but if he master the elements of mathematics and chemistry while at school, and on leaving it take up a language or a science every winter till he has a fair understanding of life and the world, he will receive the best education at his command, with the most pleasure and with no attempt at forcing. The University Extension Scheme is on these lines. Later on he can select some one subject and make it his hobby, for without some hobby the second half of life is incomplete.

Mr. Speers—Whilst Dr. Sheldon was proceeding with his lecture I was trying to realise how far Arnold's methods and views could be adopted with advantage in our Irish Intermediate Schools. If time permitted I should like to criticise his estimate of the comparative importance of different branches of study. With him classical learning was of more importance than all other branches of knowledge put together. Even English did not deserve serious study on its own basis, but should be learned only through the medium of Latin, a practice still common in English public schools. Dr. Arnold's system of training his boys in religion and morals would, I fear, be inapplicable in our Irish schools, which are attended by pupils of different religious denominations. We would soon be accused of attempting to proselytise. I believe, however, that the principle which underlay his method is adopted and acted upon by the heads of schools in our country, and that it is quite possible to carry out an effective system of moral education in our schools without inculcating the special religious tenets of any church.

Mrs. Byers—I came expecting a great treat, and I have received it. On behalf of school mistresses, I beg to thank Dr. Sheldon very heartily. I was particularly gratified to find Dr. Sheldon taking up so boldly Dr. Arnold's moral and spiritual nature. I have always thought that he, above all schoolmasters, understood the character of the Great Master, and that he unconsciously revealed that character to his pupils, perhaps not so much in words as in his upright life. I am very much obliged to Dr. Sheldon for the way in which he brought before us Dr. Arnold's love for the Scriptures. I shall go back and read the life of Dr. Arnold again, and try to get a greater inspiration from it than before for my work, after listening to Dr. Sheldon's able paper.

Dr. Sheldon—What I objected to under the name of "useful knowledge" was such awful abominations as that put before us last year by the Intermediate—the commercial education. The schoolmasters ignored it ; the parents were too sensible ; and it died a natural death. As one instance—instead of history we had the history of commerce, which may be educational when tacked on to general history, but standing alone is a mere crammer's grind. Useful knowledge, as Arnold says, is that which will fit the learners to think when they are grown up. As regards the training of observation, it may be done at all times and in all ways, and parents can do it as well as masters. With regard to the number of subjects, the only question is, as some one has said, whether you will have soup or sandwiches. The "soup" system is to give them all at once ; the "sandwich" to give two or three years at one and two or three at another. In this connection, I prefer sandwiches to soup. About the religious question, I do not think that, from the teacher's point of view, there is really much difficulty in giving Biblical teaching to the children of parents holding various views. In Manchester I had a Bible class in my day school. I did not trouble to write to any parents except to a few Jews and Unitarians. To the Unitarians I said, "I cannot teach the Bible with my views without teaching the divinity of Christ.

If your boys come to my class I must teach that." I had not a single Unitarian boy withdrawn from my class, nor a single Jew from Old Testament lessons. One thing we can all do, and that is the greatest thing of all, whether parents or teachers—we should take the religious basis for granted. In talking to a boy about right and wrong I always assume that he is a Christian boy, and I find all boys respond to that, and accept the position that as Christian boys in a Christian land they ought to be living Christian lives.

"HINTS ON COLLECTING IRISH FOLK-LORE."

By Mr. W. H. Patterson.

Mr. Patterson read his paper upon the collection of Irish folk-lore. He discussed the various modes of investigating this class of subject, and described in detail those of the British Association.

18th April, 1893.

Professor Fitzgerald, B.A., M.I.C.E., President, in the Chair.

"NOTES ON ELECTRIC POWER SUPPLY FOR TRAMWAYS AT PATERSON, NEW JERSEY."

By Professor Fitzgerald.

After a brief description of the situation of Paterson, the President gave an account of the general arrangements of the trolley car and overhead-wire system of electric tramways used in the States as exhibited in the Paterson installation. The total length of tram lines worked by electricity is about thirty miles, reckoned as single line. Nine engines with dynamos, capable of developing about 150-horse power each, generate the current, which keeps about forty cars running. The power is supplied by an electric light company, who charge for it at the rate of 11s per hundred car miles. Estimating the average power for driving a car as 8-horse power, this is equivalent to a charge of about 1½d per Board of Trade unit. The reasons for the difference between this and the charge for electricity supplied for light were pointed out. Professor Fitzgerald concluded by acknowledging his obligations to Mr. Brock, the manager of the Paterson Electric Light Supply Station, for information and his kindness in showing and explaining the works.

"THE NEW PHRENOLOGY."

By Dr. William Calwell.

The Lecturer said that the general intelligence depends on the general size of the brain, the quantity of grey matter, the texture, and blood supply ; and supported these propositions by an appeal to the evidence from comparative results in animals and in man. He then drew attention to some of the results in the localisation of functions, and showed that the ordinary tenets of the popular phrenologist could no longer be maintained.

Owing to the lateness of the hour, no discussion took place.

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Davies, John H., Glenmore Cottage,	Lisburn.
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Dods, Robert, B.A., Dunluce Terrace,	Belfast.
*Donegall, Marquis of,	do.
*Downshire, Marquis of, The Castle,	Hillsborough.
Drennan, W. H., Prospect Terrace,	Belfast.
Dudley, Rev. Freeman, M.A., The Rectory,	Kilkeel.
Duffin, Adam, M.A., LL.D., University Square,	Belfast.
Dunleath, Lord, D.L., Ballywalter Park,	Ballywalter.
Everett, Professor Joseph D., M.A., D.C.L., F.R.S., Derryvolgie Avenue,	Belfast.
Ewart, G. Herbert, Sydenham Park,	do.
Ewart, Lavens M., J.P., Glenbank House,	do.
Ewart, Sir William Quartus, Bart., Schomberg,	do.
Fagan, John, F.R.C.S.I., J.P., Great Victoria Street,	do.
*Fenton, Francis G., St. George's Villas, Strandtown,	do.
Ferguson, Godfrey W., Murray's Terrace,	do.
Finlay, Robert H. F., Hughenden Avenue,	do.
Finlay, William Laird, J.P., Arlington, Windsor,	do.
FitzGerald, Professor Maurice F., B.A., Assoc.M.I.C.E., Toronto Terrace,	do.

*Getty, Edmund (Representatives of),	Belfast.
Gibson, Andrew, Queen's Square,	do.
Girdwood, Catherine, Mount Pleasant,	do.
Gordon, Robert W., J.P., Windsor Gardens,	do.
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Greer, Thomas, J.P., M.R.I.A., Seapark,	do.
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Heburn, William, College Gardens,	Belfast.
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Herdman, John, J.P., Carricklee House,	Strabane.
*Herdman, Robert Ernest, College Gardens,	Belfast.
Heyn, James A. M., Fortwilliam Park,	do.
Hind, John, jun., Clifton Park Avenue,	do.
Hodges, Professor John F., M.D., F.C.S., F.I.C., J.P., Sandringham,	do.
Hogg, John, Academy Street	do.
*Houston, John Blakiston, J.P., V.L., Orangefield,	do.
*Hughes, Edwin, J.P., Mertoun,	Holywood.
Hyndman, Hugh LL.D., Ardenlee, Ravenhill Road,	Belfast.
Inglis, James, J.P., Abbeyville,	Whiteabbey.
Jackson, Anthony Thomas, C.E., Corn Market,	Belfast.
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*Murphy, Isaac James,	Armagh.
*Murphy, Joseph John, Osborne Park,	Belfast.
Murray, Robert Wallace, J.P., Fortwilliam,	do.
Musgrave, Edgar, Drumglass, Malone,	do.
*Musgrave, Henry, Drumglass, Malone,	do.
Musgrave, James, J.P., Drumglass, Malone,	do.
MacAdam, Robert, College Square East,	do.
M'Bride, Henry James, Glenalina,	do.
M'Bride, Samuel, Westbourne, Windsor,	do.
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M'Cormick, Hugh M'Neile, Ardmara,	Craigavad.
*M'Cracken, Francis (Representatives of).	
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M'Gee, Samuel Mackey, Cliftonpark Avenue,	Belfast.
MacIlwaine, John H., Brandon Villa, Strandtown,	do.
*MacLaine, Alexander, J.P., Queen's Elms,	do.
M'Neill, George, Beechleigh, Malone Road,	do.
Neill, Sharman D., Wellington Park,	do.
Nicholson, Henry J., Windsor Gardens,	do.
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Patterson, William H., M.R.I.A., Garranard,	do.
Patterson, William R., College Park East,	do.

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Rea, William R., Thronemount Villas,	do.
Reade, Robert H., J.P., Wilmount,	Dunmurry.
Riddel, William, J.P., Beechmount,	Belfast.
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Rowan, John, Bentinck Street,	do.
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Shillington, Thomas Foulkes, Dromart, Antrim Road,	do.
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Walkington, Thomas R., Edenvale, Strandtown, do.
Wallace, James (Representatives of), do.
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Ward, John, J.P., Lennoxvale, Malone Road, do.
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Workman, Rev. Robert, M.A., Rubane House, Glastry.
Workman, Rev. Robert, B.D., Newtownbreda.
Workman, R. D., The Manse, do.
*Workman, Thomas, J.P., Craigdarragh, Helen's Bay.
Workman, William, Nottinghill, Belfast.
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Wright, Joseph, F.G.S., Alfred Street, do.

Young, Robert, C.E., Rathvarna, do.
*Young, Robert Magill, B.A., M.R.I.A., Rathvarna, do.

HONORARY ASSOCIATES.

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Wright, Joseph, F.G.S., Alfred Street,	Belfast.

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Jones, A. L., Waring Street	do.
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Luther, W. Heinrich, M.D., Chlorine House,	do.
Lynn, William H., C.E., R.H.A., Crumlin Terrace,	do.
Macauley, P., LL.D., Stranmillis Road	do.
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Malone, John, Brookvale,	do.
Matier, Alexander S., Northleigh, Fortwilliam Park	do.
Milligen, John, Donegall Place	do.
M'Causland, William, Cherryvale House,	do.
MacIlwaine, E. N., Eglantine Avenue,	do.
M'Keller, John, Custom House,	do.
M'Laughlin, W. H., Brookvale, Antrim Road,	do.
Oakman, Nicholas, Royal Terrace,	do.
Oldham, Charles (Messrs. Workman, Clark & Co.),	do.
Osborne, Thomas Edens, Concrete Villa,	Cultra.
Paul, Thomas, Redcot, Knock,	Belfast.
Peddie, J. Finlay, C.E., Limestone Road,	do.
Redfern, Prof. Peter, M.D., F.R.C.S.I., Lower Crescent,	do.
Rogers, John, Windsor Aveuue,	do.
Ross, William A., Iva Craig,	Craigavad.
Scott, Conway, C.E., Agincourt Terrace,	Belfast.
Swiney, J. H. H., C.E., Chichester Avenue, Antrim Road,	do.
Tate, Alexander, C.E., Longwood, Whitehouse,	do.
Taylor, Sir David, J.P., Bertha, Windsor,	do.
Thompson, John, The Glen, Limestone Road,	do.
Turpin, James, Waring Street,	do.
Walkington, R. B., Linenhall Street,	do.
Wise, Berkeley D., C.E.,	Greenisland.
Wisnom, H., Fitzroy Avenue,	Belfast.
Withers, James, Laurence Street,	do.

Report and Proceedings

OF THE

BELFAST

NATURAL HISTORY & PHILOSOPHICAL SOCIETY

FOR THE

SESSION 1893-94.

BELFAST:
PRINTED BY ALEXR. MAYNE & BOYD, 2 CORPORATION STREET
(PRINTERS TO QUEEN'S COLLEGE).

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1894.

CONTENTS.

Belfast Natural History and Philosoqhical Society.

ESTABLISHED 1821.

SHAREHOLDERS.

1 Share in the Society		costs £7.
2 Shares	,,	cost £14.
3 Shares	,,	cost £21.

The proprietor of 1 Share pays 10s. per annum ; the proprietor of 2 Shares pays 5s. per annum ; the proprietor of 3 or more Shares stands exempt from further payment.

Shareholders are only eligible for election ou the Council of Management.

MEMBERS.

There are two classes—Ordinary Members, who are expected to read papers, and Visiting Members, who, by joining under the latter title, are understood to intimate that they do not wish to read Papers. The Session for Lectures extends from November in one year till May in the succeeding one. Members, Ordinary or Visiting, pay £1 1s. per annum, due 1st November in each year.

Each Shareholder and Member has the right of personal attendance at all meetings of the Society, and of admitting a friend thereto ; also of access to the Museum and Library for himself and family, with the privilege of granting admission orders for inspecting the collections to any friend not residing in Belfast.

Any further information can be obtained by application to the Secretary. It is requested that all accounts due by the Society be sent to the Treasurer.

The Museum, College Square North, is open daily from 10 till 4 o'clock. Admission for Strangers, 6d. each. The Curator is in constant attendance, and will take charge of any Donation kindly left for the Museum or Library.

Belfast Natural History and Philosophical Society.

ANNUAL REPORT, 1893.

THE Annual Meeting was held in the Museum, College Square North, on Monday, 11th June, 1894. Amongst those present were—Professor Fitzgerald (in the chair); Messrs. R. L. Patterson, J.P.; R. Young, C.E., J.P.; T. Workman, J.P.; W. H. Patterson, R. M. Young (hon. sec.), Edward Allworthy, R. A. Kyle, W. Swanston, Robert Patterson, John Brown, J. H. Davies, Dr. J. MacCormac and Dr. J. A. Lindsay.

The SECRETARY read the notice convening the meeting, after which he submitted the annual report, which was as follows:—"The Council of the Belfast Natural History and Philosophical Society appointed by the shareholders at the last annual meeting on the 21st July, 1893, desire to submit their report of the working of the Society during the past year. The winter session was opened on 20th October, 1893, by a popular lecture, kindly given by Professor G. T. Stokes, D.D., in the Assembly's Hall, May Street, on 'St. Patrick and the Valley of the Boyne.' The second meeting was held on 2nd November, 1893, when Mr. L. L. Macassey, B.L., M.I.C.E, read a paper on 'The Mourne Scheme for the Water Supply of Belfast,' illustrated by diagrams and photo slides. The third meeting was held on 5th December, 1893, when the following communications were made:—1. Mr. A. Tate, M.I.C.E., report of the Society's delegate to British Association. 2. Mr. W. H. Patterson, M.R.I.A., 'A Notice of Ancient Shell Mounds at Rosapenna, County Donegal,' illustrated by finds.

3. Mr. Douglas Lithgow, 'Gossipings about the Parish of Saul.' 4. An exhibition of the latest phonograph, kindly given by Miss Susan Richardson. At the fourth meeting held on 19th December, 1893, in the Ulster Minor Hall, a popular scientific lecture was given by Mr. William M'Whirter, of Glasgow, on 'Electrical Cooking and other Modern Electrical Inventions.' The fifth meeting was held on 2nd January, 1894, when Mr. Conway Scott, C.E., read a paper on 'National Health,' followed by a discussion. The sixth meeting was held on 6th February, 1894, when Mr. G. M. Roche, of Dublin, gave a popular lecture on 'The American Mail Service (London and New York): Liverpool-Queenstown *v.* Southampton,' illustrated by 100 lantern views. The seventh meeting was held on 6th March, 1894, when the following papers were read:—1. Mr. Robert Patterson, hon. sec. Ulster Fauna Committee, 'Notes on the Occurrences of the Marten (*Martes Sylvatica*) in Ulster,' illustrated by specimens. 2. Mr. R. M. Young on 'A Recent Find of Irish Elk Bones, &c., in Belfast.' 3. Mr. Seaton F. Milligan, M.R.I.A., 'Social Pictures of Celtic Ireland,' illustrated by specimens from the lecturer's collection. The eighth meeting was held on 3rd April, 1894, when Professor Knight, LL.D., of St. Andrews, gave a lecture on 'The Higher Education of Women.' All the meetings, particularly the popular lectures, were well attended both by the members and the general public. In this connection your Council determined in last January to make a second effort to secure a course of Gilchrist lectures for next autumn. With the valuable assistance of Mr. John Horner, who succeeded in getting four other towns to join in the scheme, the requisition sent to the Gilchrist Trustees was favourably considered by them, and their secretary intimated that a series of six lectures, commencing on 28th September, 1894, will be given at intervals of a fortnight. The lecturers will comprise some of the leading scientists of the day, including Sir Robert Ball, Rev. Dr. Dallinger, Dr. Andrew Wilson, Dr. R. D. Roberts, &c. Their secretary met your Council on 23rd April, and explained how to make the lectures

successful, describing the modes adopted in various centres in England. He will again visit Belfast on 29th June, when a town meeting will be held to make further arrangements. As this is the first time that the Gilchrist lectures have been granted to Ireland, it is hoped that the action of the trustees will be fully justified by the success of the series in Belfast and other Ulster towns. It will be observed from the hon. treasurer's report that the finances of the Society are in a satisfactory state, a substantial balance remaining in his hands. A considerable number of new members have also joined the Society. The Society's meetings in the Museum show no diminution, and it is in contemplation to erect additional accommodation for the geological work carried on by the Belfast Naturalists' Field Club. Since the last annual meeting the Society has to deplore the loss of one of its best known and valued members, the late Joseph John Murphy. He was a member of your Council for over forty-one years, and president for several years. At the public meeting of the Society held on the 6th February last, a vote of condolence was passed to his relatives, on the motion of Mr. R. L. Patterson, J.P., vice-president. Your Council have co-opted Mr. Lavens M. Ewart, J.P., to fill the vacancy caused by the death of Mr. Murphy. The Museum was opened on Easter Monday and Tuesday at the usual nominal charge. Several novelties were displayed, including some living Irish animals, and the attendance of visitors exhibited a gratifying increase. Mr. Roberts, who was appointed assistant-curator last autumn, having resigned in April, Mr. R. Robinson has been taken on trial as his successor. The Curator continues to discharge his duties with much efficiency. A list of donations to the Museum, and of publications received in exchange from home and foreign societies will be printed with the present report. Amongst the donations may be specially noted the excellent portrait, in oil, of our Curator, kindly presented by the artist, Miss S. M. Thompson, and the interesting stone carvings from Saul Abbey given by Mr. Douglas Lithgow. The Council desire to tender their best

thanks to the Press for their admirable reports of the Society's proceedings.

This meeting will be asked to elect five members of Council in place of the following gentlemen, who retire in accordance with the new constitution, four of whom are eligible for re-election—viz., Mr. Thomas Workman, J.P.; Mr. Robert M. Young, Professor J. D. Everett, F.R.S.; and Mr. Lavens M. Ewart, J.P.

The donations to the Museum, 1st May, 1893, till 1st May, 1894.—From Mr. Herman Hoell, barque Dovre, four king crabs from Florida; from Mrs. Jenkins, specimen of a rare cuttle fish (*Rosia Macrosoma*), from Helen's Bay; from Moses Atkinson, the sword of a Lisburn volunteer; from Mr. J. Beck, Donegore, a spindle whorl found in Donegore Moat; from Thomas Workman, J.P., a number of shells from Singapore; coleoptera from Madagascar; and model of an Esquimaux kayak; from the Misses Watson, Ballybandon, two sepulchral urns, found near Killinchy, filled with human bones; from W. Swanston, F.G.S., a trooper's flint-lock pistol; from Mr. J. Liddle, Cookstown, a collection of fossil fish teeth, from rocks near Cookstown; from Capt. R. Campbell, stuffed specimen of mongoose killing a snake; from Mr. Donald Cameron, fossil bones from the Pampas, Tandiel; from Miss S. M. Thompson, fossils and rock specimens from Howth; also, oil painting portrait, "A Northern Botanist;" from Mr. Thomas Carter, a wooden mether filled with bog butter, found in a bog near Portadown; from Mr. D. M'Clelland, horn of a doe, found in gravel at Orlock; from Mr. Andrew Peden, a pike, found at Donegore Hill; also a breastplate worn by Donegore Yeoman Infantry; from Rev. George Hill, portion of the fringe of an ancient Irish garment; from Mr. Wallace, Otago, green-stone adze from New Zealand; from Belfast Water Commissioners, two large specimens of petrified wood from Stoneyford; from Belfast Naturalists' Field Club, a volume of specimens of dried plants; from Mr. W. H. Patterson, M.R.I.A., specimens of bones and shells from shell mounds at Rosapenna; from Mr.

R. M. Young, M.R.I.A., bones of Irish elk, &c., dug up in Castle Place; from Miss Chermside, wings of locusts from Natal; from Messrs. Fitzpatrick & Co., human skull, dug up in Royal Avenue; from Mr. S. F. Milligan, M.R.I.A., bones of various animals, dug up in Castle Place."

The Secretary of the Ulster Fauna Committee reports that steady progress has been made during the year. The correspondence connected with the work has taken a considerable amount of time, and several important facts have been brought to light. Our knowledge of the breeding-range of Irish birds is steadily increasing. Information about Irish mammals being difficult to obtain, it has been thought advisable to take up each one separately and work out its occurrences and distribution. This has been done in the case of the marten, and a copy of the paper is on the table. To obtain this information alone eighty-three letters were specially written—a labour which many might consider not worth the result. Our observers are increasing, and general interest is expressed in our work, which can be much aided by the co-operation of the members of the Belfast Natural History and Philosophical Society.

Mr. John Brown, hon. treasurer, submitted the statement of accounts, which showed a balance of £10 2s. 2d. in favour of the Society.

Mr. J. H. Davies moved the adoption of the report and statement of accounts. He said there seemed to be an increased interest in the Society, and he hoped that that interest would continue.

Dr. MacCormac seconded the motion, which was passed.

Mr. R. L. Patterson, having made a statement with reference to the securities of the Society, &c.,

The election of five members for the Council in place of those now retiring took place, the scrutineers being Mr. Patterson and Mr. Swanston. The election resulted as follows:—Mr. Thomas Workman, Mr. R. M. Young, Professor Everett, Mr. John Horner, and Mr. L. M. Ewart.

The SECRETARY then read the following list of lectures to be given in Belfast in connection with the Gilchrist Trust:—28th September, Professor V. B. Lewes, "Our Atmosphere and its Relation to Life;" 12th October, Professor Sir Robert Ball, F.R.S., "Recent Discoveries about the Sun;" 26th October, Rev. Dr. Dallinger, F.R.S., "Spiders: Their Work and Their Wisdom;" 9th November, Dr. R. D. Roberts, D.Sc., &c., "The Evolution of the British Isles;" 23rd November, A. P. Laurie, M.A., "Waves of Water and Waves of Light;" 7th December, Dr. Andrew Wilson, "Brain and Nerve and their Work."

The CHAIRMAN hoped that they would all do their utmost to promote the success of the lectures.

On the motion of Mr. PATTERSON, seconded by Mr. WORKMAN, a cordial vote of thanks was passed to Professor Fitzgerald, who now retires from the presidentship of the Society, for the manner in which he had conducted their meetings during the past three years, and

The compliment having been acknowledged in appropriate terms,

The proceedings terminated.

EDUCATIONAL ENDOWMENTS (IRELAND) ACT, 1885, 48 & 49 Vict., ch. 78.

The Account of the Council of the Belfast Natural History and Philosophical Society for the year ended 30th April, 1894.

Dr. **Cr.**

CHARGE.

	£	s.	d.	£	s.	d.
To Amount of Donations, Bequests, and other Endowments received in the year ended 30th April, 1894				£0	9	0
,, Amount of Subscriptions received in the year ended 30th April, 1894				136	17	0
,, Amount of Dividends received in the year ended 30th April, 1894				17	9	11
,, Amount of Rents received in the year ended 30th April, 1894				35	0	6
,, Amount of Fees received in the year ended 30th April, 1894				0	5	6
,, Amount realized by Sales in the year ended 30th April, 1894				2	14	6
,, Amount of Miscellaneous Receipts in the year ended 30th April, 1894 (not included in the foregoing), viz.:—						
Entrance fees at door on Easter Monday	£27	6	1			
Do. do. Tuesday	5	13	4			
Do. do. May 1, '93, to April 30, '94	22	17	3			
				55	16	8
Total				£248	13	1

DISCHARGE.

	£	s.	d.	£	s.	d.
By Balance due Treasurer, April 30th, 1893 ...				£14	6	8
,, Amount of Payments made in the year ended 30th April, 1894, under the following headings—						
Maintenance of Premises, &c. ...	£20	15	$2\frac{1}{2}$			
Rent and Taxes, &c.	27	11	0			
Salaries	87	10	3			
				135	16	$5\frac{1}{2}$
Other Payments, viz.—						
Printing and Stationery	10	18	8			
Advertising	9	0	1			
Postage and Carriage	6	0	$8\frac{1}{2}$			
Fuel and Gas	15	14	7			
Insurance	2	12	6			
Auditor's Fee	1	1	0			
Model of Curragh purchased ...	0	3	4			
Subscription to *Irish Naturalist* ..	3	3	0			
Prof. Knight's Travelling Expenses	2	8	0			
Expenses at Easter	8	7	5			
Printing Report	20	9	0			
Popular Lecture Account	8	9	6			
				88	7	$9\frac{1}{2}$
Total Payment				£238	10	11
,, Balance in favour of this Account on 30th April, 1894				10	2	2
Total				£248	13	1

N.B.—Besides the above Balance there is a sum of £400 standing to the credit of this Account in the York Street Spinning Co., Ltd., $4\frac{1}{2}$ per cent. Debenture Stock.

We certify that the above is a true Account.

MAURICE F. FITZGERALD, Governor.
J. BROWN, Accounting Officer.

Dated this 26th day of May, 1894.

I certify that the foregoing Account is correct.
J. F. MAYNE, Auditor.
30th day of June, 1894.

DONATIONS TO THE MUSEUM, 1893-94.

From Mr. Herman Hoel. Barque " Dovre."

Four king crabs, from Florida.

From Mrs. Jenkins.

A rare cuttle-fish (*Rossia macrosoma*) taken at Helen's Bay.

From Moses Atkinson, Esq.

The sword of a Lisburn volunteer.

From J. Beck, Esq., Donegore.

A spindle whorl found in the souterrain under Donegore moat.

From The Misses Watson, Ballybundon.

Two sepulchral urns, dug up in a field near Killinchy.

From Thos. Workman, Esq., J.P.

A model of an Esquimaux kayak, also specimens of *Coleoptera* from Madagascar, and shells (*Auricula*, *Terebralia*, *Potamides*, etc.) from Singapore

From Wm. Swanston, Esq., F.G.S.

Old cavalry pistol with flint lock

From J. Liddle, Esq., Cookstown.

A collection of fossil fish palates from Carboniferous rocks near Cookstown.

From Capt. Campbell. Ship " Slieve Donard."

A stuffed mongoose in the act of killing a cobra.

From Donald Cameron, Esq.

Fossil bones from the Pampas near Tandiel, Buenos Ayres.

From Miss Sydney M. Thompson.

Oil portrait—" A northern botanist ", also fossil specimens from rocks at Howth.

From Thomas Carter, Esq.

An ancient wooden mether found, filled with butter, in a bog near Portadown.

From MR. D. M'CLELLAND.

Horn of a doe found in gravel at Orlock.

From ANDREW PEDEN, ESQ.

A pikehead found near Donegore Hill, and a breastplate worn by Donegore yeoman infantry.

From REV. GEORGE HILL.

Portion of the fringe of an ancient Irish mantle, dug up in a bog between Moyarget and Ballintoy, Co. Antrim.

From MR. WALLACE, Otago.

An adze made of jade, from New Zealand.

From THE BELFAST WATER COMMISSIONERS.

Two large specimens of silicified wood found in clay at Stoneyford.

From BELFAST NATURALISTS' FIELD CLUB.

A volume of specimens of dried plants.

From W. H. PATTERSON, Esq., M.R.I.A.

Human and other bones and also shells from kitchen midden at Rosapenna, Co. Donegal.

From R. M. YOUNG, Esq. M.R.I.A.

Bones of *Megaceros*, etc., dug up in Castle Place, Belfast, at a depth of 7 feet.

From S. F. MILLIGAN, Esq., M.R.I.A.

Bones of dog, horse, etc., dug up in Castle Place, Belfast.

From MISS CHERMSIDE, Albion Place.

A number of wings of locusts from Durban, Natal.

From MESSRS. FITZPATRICK & Co.

A human skull found when excavating at Messrs. Steel's premises in Royal Avenue.

From DOUGLAS LITHGOW, Esq.

Two carved stones from Saul Abbey, Co. Down.

ADDITIONS TO THE LIBRARY, 1st MAY, 1893, TILL 1st MAY, 1894.

ADELAIDE.—Transactions of the Royal Society of South Australia. Vol. 16, part 2, 1893; and vol. 17, parts 1 and 2, 1893. *The Society.*

AUSTIN, Texas.—Transactions of the Texas Academy of Science. Vol. 1, no. 2, 1893. *The Academy.*

Definitions of the Trigonometric Functions. By Professor A. Macfarlane, D.Sc., LL.D. *The Author.*

BELFAST.—Proceedings of the Belfast Naturalists Field Club. Ser. 2, vol. 3, part 6, 1892-3. *The Club.*

BERGEN.—Bergens Museums Aarbog, 1892. *The Museum.*

BERLIN.—Verhandlungen der Gesellschaft für Erdkunde zu Berlin. Vol. 20, parts 4-7, and part 10, 1893; and vol. 21, parts 1-3, 1894. *The Society.*

BIRMINGHAM.—Proceedings of the Birmingham Philosophical Society. Vol. 8, part 2, 1892-93; and Annual Report, 1893. *The Society.*

BOLOGNA.—Rendiconto delle Sessioni della R. Accademia delle Scienze dell Istituto di Bologna. Anno, 1891-2. *The Academy.*

BOSTON.—Proceedings of the Boston Society of Natural History. Vol. 26, part 1, 1893. *The Society.*

Occasional Papers—Geology of the Boston Basin. Vol. 1, part 1, 1893; and maps.

Memoirs of the Boston Society of Natural History. Vol. 4, no. 11, 1893. *The Society.*

BREMEN.—Abhandlungen herausgegeben vom Naturwissenschaftlichen Vereine zu Bremen. Vol. 12, part 3; also Ubersicht, two supplements. Vol. 13, part 1, 1894. *The Society.*

Breslau.—Zeitschrift für Entomologie herausgegeben vom Verein für Schlessiche Insektenkunde zu Breslau. New Series, part 18, 1893.
The Society.

Brighton.—Annual Report of the Brighton and Sussex Natural History and Philosophical Society, 1893. *The Society.*

Brussels.—Annales de la Société Royale Malacologique de Belgique. Vol. 26, 1891.

Procès-Verbaux des Séances. Vol. 21, Jany.-Aug., 1892. *The Society.*

Calcutta.—Records of the Geological Survey of India. Vol. 24, parts 2-4, 1893.
The Director of the Survey.

Memoirs (Palæontologica Indica) II. Part 1, 1893.

Manual of the Geology of India (Oldham). 2nd edition, 1893.

Cambridge.—Proceedings of the Cambridge Philosophical Society. Vol. 8, parts 1 and 2, 1893-4.
The Society.

Cambridge, U.S.A.—Bulletin of the Museum of Comparative Zoology. Vol. 16, nos. 12-14, 1893; vol. 24, nos. 3-7; vol. 25, nos. 1-6, 1893-4; also Report of the Curator, 1892-93.
Alex. Agassiz, Curator.

Cardiff.—Report and Transactions of the Cardiff Naturalists' Society. Vol. 24, part 2; and vol. 25, parts 1 and 2, 1893-94. *The Society.*

Christiania.—Forhandlinger i Videnskabs Selskabet i Christiania. Nos. 1-11, 1891; nos. 1-18, 1892; also Oversigt 1891; Oversigt 1893; and Briefe Abhandlungen und Predigten, 1890.
The Royal University of Christiania.

CHERBOURG.—Memories de la Société Nationale des sciences Naturelles et Mathematiques de Cherbourg. Vol. 28, 1892. *The Society.*

DAVENPORT, U.S.A.—Proceedings of the Davenport Academy of Natural Science. Vol. 5, part 2, 1893. *The Academy.*

EDINBURGH.—Proceeedings of the Royal Society of Edinburgh. Vol. 19, 1891-2. *The Society.*

Transactions and Proceedings of the Botanical Society of Edinburgh. Vol. 19, part 3. *The Society.*

EMDEN.—Jahresbericht der Naturforschenden Gesellschaft in Emden, 1891-92. *The Society.*

ESSEX.—The Essex Naturalist and Journal of the Essex Field Club. Vol. 7, nos. 1-12, 1893. *The Club.*

FLORENCE.—Bullettino della Societa Entomologica Italiana. Parts 1-4, 1893; part 1, 1894; also Processi Verbali, 1892, and Statuto, 1894. *The Society.*

FRANKFURT.—Bericht über die Senckenbergische naturforschende Gesellschaft in Frankfurt am Main, 1893; also Katalog der Reptiliensammlung in Frankfurt Museum. *The Society.*

GLASGOW.—Transactions of the Geological Society of Glasgow. Vol. 9, part 2, 1893. *The Society.*

Proceedings of the Philosophical Society of Glasgow. Vol. 24, 1893. *The Society.*

GIESSEN.—Neunundzwanzigster Bericht der Oberhessischen Gesellschaft für Natur und Heilkunde. 1893. *The Society.*

GÖRLITZ.—Abhandlungen der Naturforschenden Gesellschaft zu Görlitz. 1893. Zwanzigster Band. *The Society.*

HALIFAX, N.S.—Proceedings and Transactions of the Nova Scotian Institute of Science. Vol. 1, part 2, 1892. *The Institute.*

HALLE.—Leopoldina, Amtliches Organ der Kaiserlichen Leopoldino-carolinischen Deutschen Akademie der Naturforscher Achtundzwanzigster heft, 1892. *The Academy.*

KIEW.—Memoires de la Société des Naturalistes de Kiew. Vol. 12, parts 1 and 2, 1892 ; vol. 15, 1893 ; and vol. 18, part 1, 1893. *The Society.*

KHARKOW.—Travaux de la Société des Sciences Experimentales a l'Université de Kharkoff. Vol. 20, 3 parts, 1892-93 *The Society.*

LAUSANNE.—Bulletin de la Société Vaudoise des Sciences Naturelles. Vol. 29, Nos. 110-113, 1893. *The Society.*

LEIPSIC.—Mitteilungen des Vereins für Erdkunde zu Leipzig. 1892. *The Society.*

LONDON.—Quarterly Journal of the Geological Society. Vol. 49, parts 2-4, 1893 ; and vol. 50, part 1, 1894 ; also, List of Fellows for 1893. *The Society.*

Journal of the Royal Microscopical Society, parts 3-6, 1893 ; and part 1, 1894. *The Society.*

Transactions of the Zoological Society of London. Vol. 13, parts 5-8, 1893-94. Proceedings, part 4, 1892 ; parts 1-4, 1893-94. *The Society.*

MANCHESTER.—Journal of the Manchester Geographical Society. Vol. 8, nos. 4 12, 1892 ; vol. 9, nos. 1-6, 1893. *The Society.*

Transactions of the Manchester Geological Society. Vol. 22, parts 8-15, 1893-94. *The Society.*

MELBOURNE.—Proceedings of the Royal Society of Victoria. Vol. 5, 1893 ; and vol. 6, 1894. *The Society.*

MADISON, U.S.A.—Transactions of the Wisconsin Academy of Science, Arts, and Letters. Vol. 9, parts 1 and 2, 1893. *The Academy.*

MERIDEN, CONN., U.S.A.—Meriden Scientific Association; Annual Address, 1892. *The Association.*

MEXICO.—Annario del Observatorio Astronomico Nacional de Tacubaya. Ano 14, 1893, and Boletin, vol. 1, nos. 13, 14, and 16, 1883. *The Director.*

MOSCOW.—Bulletin de la Société Impériale des Naturalistes de Moscou. Nos. 1-3, 1893. *The Society.*

MADRAS.—Report of the Government Central Museum, for the year 1892-3.
The Superintendent of the Museum.

NEW YORK.—Annals of the New York Academy of Sciences. Vol. 7, nos. 1-5, and vol. 8, nos. 1-3, 1893.
The Academy.

Bulletin of the American Geographical Society. Vol. 24, no. 4, part 2, 1892; vol. 25, nos. 1-4, 1893. *The Society.*

NANTES.—Bulletin de la Société des Sciences Naturelles de L'ouest de la France. Vol. 3, nos. 1-4, 1893.
The Society.

OTTAWA.—Geological Survey of Canada; Annual Report. Vol. 5, parts 1 and 2, and 5 maps, 1893. Catalogue of Section I. of the Museum, 1893; also catalogue of a stratigraphical collection of Canadian Rocks, 1893. *The Director.*

PADUA.—Atti della Societa Veneto-Trentina di Scienze Naturali in Padova. Series 2, vol. 1, fasc. 2, 1894; and Bullettino. Vol. 5, no. 3, 1893.
The Society.

PHILADELPHIA.—Proceedings of the Academy of Natural Sciences of Philadelphia. Part 3, 1892, and parts 1 and 2, 1893. *The Academy.*

Proceedings of the American Philosophical Society. Vol. 31, nos. 140-141, 1893. *The Society.*

Transactions of the Wagner Free Institute of Science. Vol. 3, part 2, 1892. *The Institute.*

PISA.—Atti della Società Toscana di Scienze Naturali Processa Verbali. May, 1893, till January, 1894. *The Society.*

ROME.—Atti della Reale Accademia dei Lincei. Vol. 2, 1 semestre, fasc. 7-12, 1893; and 2nd semestre, fasc. 1-12, 1893; vol. 3, 1st semestre, fasc, 1-7, 1894. *The Academy.*

Bollettini della Societa Romana per gli Studi Zoologici. Vol. 2, parts 1-8, 1893. *The Society.*

Journal of the British and American Archæological Society of Rome. Vol. 2, no. 3, 1893. *The Society.*

ROCHESTER, N.Y.—Proceedings of the Rochester Academy of Science. Vol. 2, part 2, 1893. *The Academy.*

REIGATE.—Proc. of the Holmesdale Natural History Club for 1890-92. *The Club.*

STOCKHOLM.—Royal Swedish Academy; Handlinger. New series, vol. 22, parts 1 and 2, 1886-87; vol. 23, parts 1 and 2, 1888-89; vol. 24, parts 1 and 2, 1890-91; Bihang. Vols. 14 to 18, in 20 parts, 1889-93; Öfversight. No. 46, 1889; no. 47, 1890; no. 48, 1891; no. 49, 1892; Lefnadsteckningar Vol. 3, part 1, 1891; Förteckning ofver innehallet, 1826-83, 1884. *The Academy.*

SAN FRANCISCO.—Procedings of the California Academy of Sciences. Series 2, vol. 3, part 2, 1893; Occasional Papers. Vol. 3 and 4, 1893. *The Academy.*

SANTIAGO DE CHILE.—Verhandlungen des Deutschen Wissenschaftlichen Vereines. Vol. 2, parts 5 and 6, 1893. *The Society.*

STAVANGER.—Stavanger Museums Aarsbereting for 1892. *The Trustees.*

TOKIO.—Mittielungen der Deutschen Gesellschaft für Natur- und Volkerunde Ostasiens in Tokio. Vol. 6, parts 51, 53, 1893. *The Society.*

TOPEKA, U.S.A.—Transactions of the Kansas Academy of Science. Vol. 13, 1891-92. *The Academy.*

TORONTO.—Transactions of the Canadian Institute. Vol. 3, part 2, 1893, and 5th Annual Report, 1892-3. *The Institute.*

TRIESTE.—Bollettino della Societa Adriatica di Scienze Natural. Vol. 14, 1893. *The Society.*

VENICE.—La Notarisia Commentario Ficologico. Nos. 1-6, 1893. *The Editor.*

VIENNA.—Verhandlungen der Kaiserlich-Koniglichen Geologischen Reichsanstalt. Nos. 2-18, 1893; and nos. 1-4, 1894. *The Society.*

Verhandlungen der Kaiserlich-Koniglichen Zoologische-Botanischen Gesellschaft in Wein. Vol. 43, parts 1 and 2, 1893. *The Society.*

Jahres-Katalog pro 1894, des Wiener Botanischen Tauschivereines. *The Society.*

WASHINGTON.—United States Geological Survey, Annual Report, 1889-1890. Part 1, Geology; part 2, Irrigation. Bulletins, nos. 82-85, 1891-92. Mineral Resources of the United States. 1891. Monographs, no. 17, Flora of the Dakota Group, 1891; no, 18, Gastropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey, 1892; no. 20, Geology of the Eureka District of Nevada, 1892. *The Director.*

Smithsonian Publications. Report of the United States National Museum, 1890. Bulletins of the Museum, no. 39, parts a to g, 1891-92, and no. 40, 1892. Smithsonian Contributions to Knowledge, no. 842, The Application of Inter-

ference Methods to Spectroscopic Measurements, 1892. Miscellaneous Collections, vols. 34 and 36, 1893. Bureau of Ethnology, Annual Reports, 1886-87 and 1887-88. Bibliography of the Chinookan and Salishan Languages, 1893. Annual Report of the American Historical Association, 1891. United States Department of Agriculture, Report of the Secretary, 1891. Division of Ornithology and Mammology, Bulletins 3 and 4. Division of Botany, vol. 4, 1893, and vol. 1, no. 8, 1893. Contributions from the United States National Herbarium, vol. 4, 1893, and vol. 1, no. 8, 1893, Transactions of the Anthropological Society of Washington, vol. 3, 1885.

The Institution.

YORK.—Reports of the Yorkshire Philosophical Society, 1892 and 1893. *The Society.*

ZURICH.—Vierteljahrschrift der Naturforschenden Gesellschaft in Zurich. Parts 3 and 4, 1892, and 1-4, 1893: Neujahrsblatt, 1893. *The Society.*

From ROBT. LLOYD PATTERSON, Esq., J.P., F.L.S.—Proceedings of the Linnean Society, 5 parts, 1883-92. Journal of the Society—Botany, vol. 20, nos. 130 and 131, and vols. 21-25. Also Zoology, vol. 18, vol. 19, parts 108-113 and 115, vol. 20, parts 116-125 ; vol. 21, parts 126-131 ; vols. 22 and 23, and vol. 24, parts 149-156, 1884-1893. Meyen's Botanical Geography, 1846.

From THOS. WORKMAN, Esq., J.P.—Exploration Scientifique de la Tunisie, 2 parts 8vo. and 1 part folio (figures of cretaceous fossils).

From G A. Holt, Esq., Manchester.—Vasey's Monograph of the Grasses of the South-west of the United States, 2 vols., 1890-91. Also, Grasses of the Pacific Slope, 2 vols., 1892-93. Agricultural Grasses and Forage Plants of the United States, and Contributions to the United States National Herbarium, 2 parts, 1892-93.

BELFAST

NATURAL HISTORY & PHILOSOPHICAL SOCIETY

SESSION 1893-4.

20th October, 1893.

PROFESSOR M. F. FITZGERALD, B.A., M.I.C.E., President, in the Chair.

Rev. Dr. STOKES, M.R.I.A. Professor of Ecclesiastical History, T.C.D., delivered a lecture, entitled

"ST. PATRICK AND THE VALLEY OF THE BOYNE."

REV. DR. STOKES, who was cordially received, said it had been oftentimes remarked that Irishmen had been incurious about their own country, about their own antiquities, about their own nationality, and the thing was too true. If they wanted to know how true it was, let them ask how many people in that room had ever seen that most wonderful specimen of caligraphy in the world, the Book of Kells, and he ventured to say that the people who had seen it were very few—he could count them on the fingers of both hands—and yet that wonderful book lay for inspection by every visitor to the library of Trinity College, Dublin. They treated such antiquities with the supremest neglect, although, at the same time, the very men who treated the Irish antiquities with neglect would be found crowding the Royal Academy in London, or crowding the museums of France and Germany. How many persons had ever visited the valley of the Boyne, and crossed it, the place which changed the history of Europe ? And yet Lord Macauley

thought it worth while to come and spend his holidays in that most beautiful valley. He lost patience here with the Irish people, for thousands amongst them went every year to visit England, and hundreds of Belfast people were to be found every year at Harrogate enjoying its springs. And yet those very people had not seen the mountains around Lough Derg, and in the centre of Ireland, which was about two hours' run from this city, the scene of the wanderings of St. Patrick in the valley of the Boyne. But they were not the offenders. The offenders were the directors of the Irish railways. He hoped if there was one present that evening that he would search his own heart and examine his own conscience, and confess in the most primitive Christian manner before this congregation. Irish traditions stated that St. Patrick was a gentleman and that he came of decent people. About the years 431 or 432 St. Patrick sailed from France to Ireland. He first landed at the point of Wicklow where there was a great strand, called the Murrow. Wicklow was greatly resorted to at the present day by riders of horses and for the manœuvres of the Dublin and Wicklow Militia Artillery. The Irish people did not receive St. Patrick very cordially when he landed. They saluted him with volleys of stones, one of which struck one of his companions. He laboured there and founded a church, and then wandered along the East coast of Ireland for a few months. Then about the spring of the year 431 or the year 432 he landed at the River Boyne, and proceeded to survey the shores and to examine its beauties. He might inform them that the Boyne sprang from a well dedicated to the Holy Trinity, about which there was a curious legend, namely, that if anyone went near that well except the King he or she should lose their sight. However, a body of men called the Irish Ecclesiastical Committee were formed in Ireland, and he might say that they were even worse than the Danes. They destroyed everything, even sanctuaries, but they vanished off the face of the earth. St. Patrick sailed as far up the Boyne as he could, when he was stopped by the rapids which were on the river in every direction. He travelled in a

kind of boat called a coracle, and they could still see some of those peculiar boats used on the South and West coasts of Ireland, and not only there but on the Shannon. The first spot he came to was that on which modern Drogheda now stood, and he afterwards came to Oldbridge, where a monument marks the spot where King William was wounded by a cannon ball on the evening of the 1st July, 1690. It might not be exactly known how that battle was won. The night before the battle of the Boyne King William was informed that there would be a difficulty in getting across the Boyne in consequence of there being only one bridge at Slane, which, however, was guarded by a small body of men under King James. He accordingly sent the Duke Schomberg's son, with twelve thousand men, who on the following morning, in conjunction with King William's force, completely crushed the six hundred men who guarded the bridge, and secured the place. There was a place above that called Rossnaree, St. Patrick followed on to Slane. Doubtless a ford existed where the bridge remains. He was seeking Tara, the capital of the country, and he selected the hill of Tara, which was then the highest hill in the County of Meath, and on that hill he raised up a statue against Celtic paganism. Looking up the Boyne, they could behold a series of views which were unsurpassed in Ireland for beauty. They could go along the Boyne's banks, either in the early spring, when the primroses decorated the ground, or else when it lay sweltering beneath the summer sun, or in the autumn, or in the middle of winter, and they would find a place along the banks of the Boyne rich in all things which could alone interest them. There was a house erected in that place for the reception of George IV. He considered it a pity that the Royal visits should be so infrequent that houses had to be erected for their reception. The ruins of Castle Dexter and Dunmore Castle could be seen further up. In fact, the whole banks of the Boyne were marked by one long series of castles, placed there by the Norman conquerors, and proving that the Boyne was for some time a very important boundary to the English.

Some of them were magnificent specimens for an archæologist, rivalling the ruins of Conway and Carnarvon themselves. If they took a tour round the Boyne they would thank the lecturer for having told them of St. Patrick and the valley of the Boyne.

The lecture was profusely illustrated by special lantern slides, the lantern being manipulated by Mr. James M'Cleery, of the Y.M.C.A. Camera Club. Some of the illustrations were of the raths, round towers, and cromlechs at present in existence, of which the lecturer gave a very clear explanation.

Mr. W. Gray moved a vote of thanks to the lecturer, and in doing so said he had accompanied him on some of his archæological excursions, and he had always found him to be a very pleasant and agreeable companion. They all hoped it would not be the last time that he would favour them with a lecture.

Mr. W. H. Patterson seconded the motion, which was passed by acclamation.

2nd November, 1893.

Professor FitzGerald, B.A., M.I.C.E., President, in the Chair.

Mr. L. L. Macassey, B.L., C.E., gave a Lecture on

THE MOURNE WATER SCHEME.

The Lecturer, in opening, said he only intended to give a brief description of the salient points of the scheme sanctioned by Parliament during the last summer. Having regard to the season of drought through which they had just passed, it would, he thought, be deemed a wise and proper measure on the part of the Commissioners to augment their supply. The population of Belfast was about 280,000, of which 260,000 were within the borough proper. The quantity of water consumed by them was 36 gallons per head per day, which, though it looked liberal, was not an extravagant supply considering that it covered both domestic and manufacturing wants. In Dublin the consumption was 40 gallons per day per individual, while in Glasgow it was something like 50 gallons. The Commissioners found the population and requirements of the city increasing, and determined to secure a supply of water which would enable them to meet any contingencies for some years to come. Every district capable of affording a good supply in the counties of Antrim and Down had been carefully examined, and it was only after a very painstaking comparison that the Mourne scheme was adopted. By the Act of 1893 the Commissioners took control over 9,000 acres of gathering ground in the Mourne Mountain district, embracing the Kilkeel and Annalong Rivers. The rainfall in this district was considerably greater than that in Belfast owing to the greater elevation.

In Belfast the average rainfall in the year, taken from the gauge at the Queen's College, was some 34 or 34½ inches, but in the neighbourhood whence it was proposed to take the water—some 1,500 feet above the ordnance datum of low water —it was much more. For instance, in the past year, which, as they knew, had been a dry one, the rainfall in Belfast had been 28 inches, while on the mean level of the proposed catchment area it was 54 inches. Allowing 15 inches as a margin for waste there would be 39 inches left as water which might be collectable. A further deduction, however, must be made for very heavy floods, the water of which could not be stored. Therefore a calculation was based on a rainfall of 28 inches, which gave something like 16,000,000 or 17,000,000 gallons per day. The gross consumption in Belfast at present was from 10,000,000 to 10,500,000 gallons per day, so that the new supply would enable the Commissioners to satisfy the wants of a population more than double that of Belfast at present. But, in addition, other catchment areas adjacent might be taken in if occasion arose, and a supply of water amounting to 30,000,000 gallons a day could be brought into the city. So that, though the scheme as at present contemplated was an ample one for all estimated future wants, it was also an expansible one which could be made to meet the most severe demands upon it due to the rapid growth of population during the next half century. The character of the district was one well suited to the purposes of a water supply. The slopes generally are steep, and, though there are patches of bog, one of the worst of these patches was excluded from the area over which the Commissioners had taken control. The water, however, might be slightly coloured by peat. But, judging from results, it seemed as if the sand carried down from the higher levels, which were particularly sandy, acted in the course of the water in such a way as to carry the peat down and subside it. In a valley called the Happy Valley, or Silent Valley, it was proposed to construct a large reservoir. This reservoir would be about two hundred acres of water surface, seventy feet deep against the

embankment—about the same depth as the deepest reservoir at Woodburn. The embankment is five hundred yards long, and the maximum depth of the reservoir would be eighty-five feet. Its capacity would be something like two thousand million gallons. This would represent about the total capacity of all the Commissioners' reservoirs at Carrickfergus and Stoneyford. The Commissioners had also the power to make a reservoir in the Annalong valley, though they did not propose to do so just now. The only condition by which the Commissioners were bound in reference to water rights was to give a supply to the village of Kilkeel—a condition which Lord Kilmorey, the owner of the land, desired to have made. There were no mills or farms to be supplied, and in fact there would be no waste or alienation of any considerable part of the water. The Commissioners had succeeded in doing what no other corporation in England or Scotland had done—namely, to get the water rights almost totally devoid of the usual obligations as to supply to adjacent interests. With regard to the quality of the water, most satisfactory reports upon analysis had been issued by Mr. Robert Barklie and Professor Dewar. The latter eminent authority—the most eminent probably on water questions—had gone over the whole district and examined it thoroughly. He described it as one of the most favourable districts for a water supply he had ever seen. The lecturer then described the method of construction of the conduit which is to bring the water from the district to Belfast. The main conduit will be $34\frac{1}{2}$ miles in length, of which $16\frac{1}{4}$ miles is what is technically known as "cut and cover," 12 miles steel pipes and the balance of $6\frac{1}{4}$ miles is tunnel. The interior of the conduit in both "cut and cover" and tunnel portions will be concrete. A service reservoir will be constructed at the "Half-way House" on the Ballynahinch Road, some three or four miles from Belfast. It will have a capacity of some 70 million gallons, or about a week's supply at the present rate. The Commissioners have obtained powers to discharge water into all rivers along their line so that there will be no difficulty with flooding, &c.

It is not proposed to construct this large reservoir in the Happy Valley immediately. The first object is to make the conduit and establish connection between these rivers and the town, so that a large amount of water could be brought in without being stored—water obtained from the ordinary flow of the rivers. It is estimated that the work will cost about £750,000, and having regard to the large sums which have been and are being expended in towns like Glasgow, Liverpool, Birmingham, and Manchester, the expense for the quantity of water available is very moderate, simply because the circumstances are very favourable in this district as compared with many others. In conclusion, the lecturer paid a high tribute to the care, intelligence, foresight, and watchfulness exhibited by the Commissioners and by their able Secretary, Mr. Hamilton, in connection with the scheme and the negotiations necessary to secure its authorisation by Parliament. He also spoke highly of the former services to the Trust of the late Mr. Colligan, and expressed the belief that the death of that gentleman was deeply regretted by all his brother Commissioners, and regarded by them as a real loss to the Trust.

Professor FitzGerald — Before calling upon any of the gentlemen to take part in the discussion, I will read a letter which Mr. Young has received from Professor Letts. It is as follows :—" I very much regret that I cannot be at the Museum this evening, and so shall miss the pleasure of hearing Mr. Macassey's paper, which I am sure will be most interesting. I should have liked to say a few words in the discussion following the paper, because, as you know, I take a great interest in the subject of the Belfast water supply, and have some very strong opinions on the subject, which I have not hesitated to express. As I cannot be present in person, may I ask you to read to the meeting the following remarks:—In the first place, I very much regret to say that the present supply, bad enough as it used to be, has become decidedly worse of recent years. Taking the quantities of free and albumenoid ammonia as indices of

organic, and therefore of dangerous pollution, I have found the following amounts expressed in parts per million :—

	1885-86.	1892.	1893.
Free ammonia	·00	·02	·005
Albumenoid ammonia ...	·15	·20	·21

These figures become more eloquent when I tell you that a very high authority on water analysis says—'Free ammonia being absent or very small, a water should not be condemned unless the albumenoid ammonia reaches something like ·10 parts per million. Albumenoid ammonia above ·10 begins to be a very suspicious sign, and over ·15 it ought to condemn a water absolutely.' Belfast is badly in want of a new water supply, and I rejoice that the Commissioners have decided to push on the Mourne scheme with all haste. The ratepayers ought not to object to an additional tax for the purpose, and I am convinced that they would not do so if they knew how bad the present supply is and what serious risks they run by its consumption. As to the excellence of the Mourne water there can be no question, as I have proved by my own analysis. I am indebted to Mr. Thompson, of Glassdrummond, for collecting the sample of Kilkeel River water, of which I append the following analysis:—Kilkeel River water, 1893; the sample was clear, colourless, and with no sediment. Total solids, 6·4 grains per gallon. Hardness, temporary, 0; permanent, 1; total, 1. Chlorine, 0·8 grains per gallon; ammonia, free, ·00; albumenoid, ·06. It is in fact a water of great organic purity, collected from an area where, I believe, there is no chance of dangerous pollution, and in every way fitted for the wants of a large town like Belfast. Not only is it a splendid drinking water, but owing to its remarkable softness it is pre-eminently suitable for industrial purposes, such as washing and scouring linen and for supplying steam boilers. In connection with the subject of hardness, I have made a calculation which may interest the audience this evening. If we suppose that each individual of the 273,000 inhabitants of Belfast uses one gallon of water daily for washing purposes, then taking the hardness

of the water as 7·5, the total waste of soap amounts daily to 2,925 lb., while with the Mourne water the waste would only be 390 lb. In a year these figures reach the totals 1,067,625 and 142,350 respectively. Further, taking soap as costing 3d. per lb., the annual expenditure of the total population on this commodity amounts, on the above assumption, to £13,340, whereas with the Mourne water the cost will only be £1,779, a saving per annum of £11,561. At this rate the money saved the ratepayers in soap would very soon cover the total outlay for the new scheme. In conclusion, it is my firm belief that the new water supply, coupled with the new drainage scheme, will have a very marked influence in lowering the death rate of the city, which, as everyone present knows, is far too high, and I also think that their influence will be specially felt in checking the amount of typhoid fever which is so prevalent in the town that I believe Belfast now enjoys the very unenviable reputation of being the premier town in the kingdom as regards the amount of this disease."

The only remark I have to make is that I have myself been frequently in those mountains, and have found that the water is very tempting to drink. One is disposed to take a great deal too much water without diluting it with anything else.

Professor Everett—I feel much obliged to Mr. Macassey for the remarkably interesting sketch he has given us of a scheme that seems so utterly free from any weak point. I have done my best to find out weak points, but I cannot see any suspicion of one. I think the Commissioners have been very quick about the matter. Quite recently they were discussing whether the best supply would be got from the Mourne district or from Lough Neagh, but they have now got everything cut and dry and carried by Parliament with wonderful completeness. I should like to ask Mr. Macassey how many storage reservoirs there are? (Mr. Macassey—One storage and one service; the numbers on the diagram are Parliamentary numbers). As to the quality of the water, anyone who has lived at Newcastle can bear witness that the water there is remarkably

soft for washing and good for drinking, and this site appears to be the very best from which water could be obtained.

Dr. LINDSAY—I have only one opinion with regard to the scheme which Mr. Macassey has explained to us in such a lucid manner—that it is the right and natural one. It has, among other merits, the great merit of offering prospective finality. I am only expressing my own private opinion, but I do not think we can consider our present supply more than about third-rate in quality. It is a fairly pleasant water, but it contains a large amount of vegetable matter. If filtering is done it is a moderately good water. The effect upon the health of Belfast with the Mourne scheme will be most beneficial. Our death-rate is certainly 5 per 1,000 too high. We have a great deal too much typhoid, and we have also to face the possibility of cholera coming here. Any precaution taken against cholera would reduce the amount of typhoid and other diseases. I should like Mr. Macassey to mention the time it would take for the carrying out of this work. We heard eight years, but it would be extremely desirable that that time should be shortened if possible.

Mr. JOHN BROWN—I have listened with great interest to Mr. Macassey, particularly as I am very well acquainted with the district to be taken in by this scheme. There was one statement made which gave me very great pleasure—namely, that peat was a wholesome addition to the water, in fact, necessary in order to make it wholesome ; because I think I can guarantee from an intimate knowledge of the district there will be a very large amount of peat. I have got a sample here of Mourne water which was taken after six hours' rain in July, 1892, and a second sample taken after the flood had settled a little. This latter is not so visibly black. These are not taken from one of the rivers which the scheme passes round, but from a river about a mile and a half from Annalong. The audience need not congratulate themselves upon that point, because all these rivers are alike, all rise in large peat bogs, which are stirred up as the rain comes down. I gathered from Mr. Macassey that

he anticipated that this peat will settle. I do not know whether he expects it will settle in the reservoirs, or in the conduit, or in the people. My opinion is that peat does not settle rapidly. These rivers run down very rapidly, and what comes down in the shape of clear water is really spring water, filtered through the sandy parts of the mountains, whereas the dirty water is peaty water that comes down direct off the surface. I do not wish to throw any cold water on the scheme ; I merely wish to point these things out for the information of the citizens who have to pay for the work, and I, of course, leave it to the engineers to say what is going to be done with the peat which contaminates I may say, from an approximate calculation, three parts of the water flowing down the mountain rivers in the district from which the new supply is to be taken.

Mr. Conway Scott—I am, and always have been, in favour of the Mourne scheme. Mr. Macassey says adopt the Mourne scheme for one reason, and one reason only—your present supply is too small. Granting that, I say there is another reason, and a more important reason, that your present supply is unsatisfactory (I do not wish to go the length of Professor Letts or Mr. Brown), it is not a good drinking water. I think it is an absolute necessity to get a new water supply, and there is no place where you will get such a supply as at the Mourne mountains. Regarding the objection raised by Mr. Brown, I do not know that you will go anywhere without getting bog, but if the Water Commissioners have purchased out all the ground at low rates, why not spend a few more thousands and cut the bogs out altogether ?

Mr. Francis Curley—I would like, Mr. President, to ask Mr. Macassey, through you, how it is that we have got such an inadequate supply from the Stoneyford scheme ? If there is a large amount lost owing to the construction of the reservoirs ? and if it is a fact that an eminent authority gave very high certificates with regard to the Lough Neagh scheme, which were kept from the public ?

Mr. P. C. Cowan—On the whole, we have a fair working

supply of water in Belfast, and while many important industries have been crippled or paralysed in Dublin on account of scarcity of water during the unusually dry season, I am not aware of any similar experience in Belfast. As regards the quality of the water coming off the Mourne mountains, Mr. Brown has put before you his experience of one river which he admits is not included in Mr. Macassey's scheme. I would ask you to think of another stream in the same region, that which gives the water supply of Newcastle, County Down. I have never drunk better water, and I believe its excellence is well known to many of you. Is it not far more reasonable to expect, with a knowledge of the good quality of the Newcastle water, that the proposed new Belfast supply will be excellent than to take Mr. Brown's sample from a stream not included in the scheme as representative? It is well known that in every large scheme provision must be made to get rid of some unsuitable water, and I doubt not this will be attended to in the new works. It so happened that recently I had to take part in a committee room in the House of Commons in an opposition to some detail points of the Bill for the Mourne Water Supply, and I can assure you I was much impressed with the care and ability with which the interests of the citizens of Belfast are attended to by the Water Commissioners and by their secretary and engineer.

Professor FitzGerald—I think a great deal too much stress has been laid upon the bog stain in the water, which is only evidence that the water has been in bog, and does not prove that there is any harm in the water. I believe, as Mr. Scott said, it would be almost impossible to find a place absolutely free from bog and where you would not be able at some time to collect numerous specimens of water such as Mr. Brown produced. It occurred to me that if sandy soil will clear water so as to take out the bog stain, there is no obvious reason why it should not be done in this case, where you have got an opportunity of passing it through large quantities of gravel afterwards, there being no restriction in the amount of natural gravel beds that could be taken outside the storage reservoirs.

Mr. Greenhill—I inferred from Mr. Macassey's remarks that he estimates that the present arrangement will provide for a double population of Belfast. I think if manufacturers increase their works as they have been doing in the past, it will require a very much larger quantity of water than double, assuming that the population of Belfast increases to twice the present number. Many wells in Belfast have become practically dry, and those who have adopted the Commissioners' water will not regret it. I had several cases under my immediate observation where the greatest possible advantage arose through taking the water from the Commissioners rather than from wells. With regard to the steel pipes, I would ask Mr. Macassey whether it would not be safer, instead of bringing the water in a large pipe, under an enormous pressure of perhaps 150 to 200 lbs. to the square inch, to bring it in sections, because if an accident occurred it would in all probability cut off the supply until the pipe was repaired. Would it not be therefore wiser, from a mechanical point of view, to use a number of small pipes side by side?

Mr. Macassey—As regards the steel pipes which have been referred to, there is no doubt that chances of failure to the pipes would be reduced by having a number of small pipes. The objection is the matter of expense. It comes to be a matter of policy whether we save £10,000 and run the risk of a loss of £100 a year, or whether we shall spend £10,000 and not run the risk I have mentioned. It is proposed that at the risky places the pipes should be duplicate, so that in the case of a failure we could turn the supply and send it on. As I mentioned in connection with the service reservoir, we reckon on the possibility of having a failure which may take a week to repair and be able to keep up the supply. As regards the Stoneyford scheme, it was framed to give about 3 or 3½ million gallons a day, and it has given that by actual experience. There is no loss of water at Stoneyford. I think that what has given rise to the point is the fact that the Commissioners are bound to send down compensation water to the millowners.

The Commissioners in making up that compensation water are entitled to take credit for the flow of water off the lower district. That is the only loss of water, if you can call it so. The idea that the scheme has failed is an erroneous one, and I am very glad to have the opportunity of stating so here. Lough Neagh has also been brought into the discussion. It was suggested—in fact, stated—that some certificates had been obtained with respect to the quality of the Lough Neagh water (I presume this meant by the Water Commissioners), and that these had been suppressed. As I am fully conversant with everything that took place I am able to give a direct and emphatic contradiction to that statement. The Water Commissioners never suppressed any document which came into their possession. They took the opinion of the most eminent authority on water questions (Professor Dewar), and he advised them not to get the Lough Neagh water. Mr. Robert Corry is quite right in his criticisms of my observations with regard to the construction of the pipe part of the conduit. I did omit to state that in the construction of the tunnel part, or of the "cut and cover" part, it would be a serious matter if in 25 or 30 years we had to make a new conduit, that is, on the assumption that we made the first one merely sufficient for the ten million gallons. It would therefore be better to make the work fully satisfactory at once. I come to the question of quality, and I feel myself in a very considerable difficulty, but I think the audience will be inclined to say that the weight of the evidence is rather in favour of the view that the Mourne water is of good quality. Professor James Dewar, F.R.S., is a man of immense experience, who has gone over the ground, not alone in fine weather, but in a heavy snowstorm. He says, on looking at the district, "You will get a good quality of water there, suitable for domestic purposes," and he further says, that the catchment is one of the best he has ever known. I ask the audience, then, to weigh the evidence. We have Mr. Gray, who knows a good deal about this district, plus Professor Letts, and we have Professor Dewar, one of the highest

authorities on the subject, whose opinion before a Parliamentary Committee on the question of the quality of water would pass a Bill or throw it out. And on the other hand, what have we? We have Mr. Brown's bottles of black water, taken from a river with which the Commissioners do not propose to interfere. Some time ago a gentleman wrote a letter to the *Northern Whig* calling attention to the fact that some of this water was very boggy, and he sent a bottle to the office of the newspaper, inviting inspection. Well, I was informed by a friend who went to see this bottle about three days after it had been deposited that it afforded a remarkable proof of the fact I described to-night. He found that a lot of black stuff in it had settled in the bottle, and the remaining water was as pure as anyone could wish for. I think Mr. Brown was the gentleman who sent the water. As to Professor Letts's communication about the quality of the Belfast water, no doubt the present supply from Stoneyford or Woodburn does not come from an area or areas equal in character to that in the Mourne district, but they will compare with many of the areas in operation in different places in England and Scotland, and you may look for a very fair quality of water. At the present time our water is nearly all filtered, but the works are not complete. Looking at the water which comes out of the filters it is bright and pleasant, and if the consumers got their pipes and cisterns well cleaned out there would, I am sure, be no complaint. Dr. Lindsay made an observation with regard to the influence of the water supply on typhoid fever. I cannot say whether he is wright or wrong in the conclusion he drew. Until the present it was admitted that the quality of water in Dublin was of a very high class, yet is it not a fact that Dublin headed the list in typhoid fever? I must conclude now by thanking the ladies and gentlemen present who have taken such a very strong interest in the details which I have had to submit to them.

5th December, 1893.

Professor FitzGerald, B.A., M.I.C.E., in the Chair.

Mr. W. H. Patterson, M.R.I.A., read a very interesting Paper on

THE ANCIENT SHELL MOUNDS AT ROSAPENNA, COUNTY DONEGAL.

The Lecturer illustrated his remarks by a numerous collection of "finds," which he presented to the Museum. The "finds" were diverse in their character, and their association with the early inhabitants of this district was very evident. For the most part they were fossilised remains of animals, which, according to Mr. Patterson, had enjoyed life about the 9th or 10th centuries.

Mr. Wm. Gray, M.R.I.A., said that Mr. Patterson's paper referred to phenomena well known round the country, and were associated with sand dunes, he might say, wherever to be found. He agreed with Mr. Patterson that the remains belonged to the 9th or 10th centuries, and clearly did not belong to the period three or four hundred years before Christ, such as the remains found at Ballintoy and Dundrum.

Report of Mr. A. Tate, C.E.,

Delegate from Belfast Natural History and Philosophical Society to Meeting of British Association at Nottingham, 1893, *on the Conference of Delegates of the Corresponding Societies at that Meeting.*

As the Delegate from your Society to the Corresponding Society's Committee of the British Association, at its last

meeting, held in Nottingham, I have been requested by your Secretary to give you some information in regard thereto.

In the opening remarks of the Chairman of this Conference, Dr. Garson, reference was made to what he considered an inadequate appreciation by the Societies of the privileges and advantages of joining in these Conferences. Among these he specially mentioned the great advantage it was to the workers in the various Societies to have the titles of their papers printed and published in the annual reports of the British Association. He also mentioned that the transactions of the various Corresponding Societies were bound and kept available for reference in the library of the British Association at Burlington House. But, surely, the claim for advantage should not be deemed to end with the benefit to the authors of these papers, but might be shared by all the members of the different Societies, and an even larger public outside them. To give some idea of what this possible benefit means—a reference to the list of papers in but a single volume of the British Association reports, that of the Edinburgh meeting, the latest published—I find that in it are included the titles, authors' names, &c., of about 500 papers, and these classified under the different sections of the Association from A to H.

Supposing that a member of our or any other of the allied Societies desired information in regard to any subject, at the time of special interest to this member, a reference to these lists in some of the back volumes of the British Association reports would, not improbably, open up to him or her a means of obtaining what was desired, or some help towards it. Attendance at Burlington House would not be indispensable. An application to the Secretary of the Society would, no doubt, at once receive a favourable response.

The Conferences commenced to be held in 1886. The number of Societies now in correspondence is 86. Belfast for many years has had this Society and the Belfast Naturalists' Field Club joining in the good work and sending delegates to represent them.

In section A, Mr. Symons, Chairman of the Committee in connection with Meteorological Photography, stated that they had received, in all, 467 photographs of clouds, and that the Committee did not press for more. They intended to select the typical ones and have them brought to a uniform scale in order to promote their general utility. In the Committee's report the study of the changes in the high level clouds is mentioned as the only branch needing further elucidation, and as this was a work of considerable difficulty, requiring special skill, appliances, and much leisure, it would be specially provided for. Very high commendation has, however, been given to the photographs of this class furnished by an Irish gentleman, Mr. Greenwood Pim, of Dublin, whose further offer of aid has gladly been accepted.

The great want felt was for an efficient atlas of the higher clouds. The Committee sought for power to arrange for the publication of a provisional atlas as a commencement. The available funds, however, at the Nottingham meeting appear not to have sufficed to permit of an enlarged grant to this Committee.

There is still a need for further photographs of lightning The report affords a full explanation of what has been done in this direction, and the best method to be adopted.

In section C the representative of the Geological Photography Committee stated that they were publishing their fourth report this year. They had received 40 new photographs, making the total collection 846, and their appeal had been more successful than in any previous year, but there was still much to be done, and he hoped the Delegates would stir up their Societies on this point. As to the best camera, the most portable was to be preferred. Many photographs had been sent in without the name of the Society, of the photographer, or of the place photographed. It had been decided not to lend any more photographs to the Societies unless duplicates were furnished. The Committee are ready to receive any good photographs, irrespective of size. It was a satisfaction to know that in the

collection several of our Belfast members had rendered good aid, and I noticed with pleasure this year some admirable enlargements from negatives made by one of our lady members. Mr. William Gray, who is a member of this Committee, will, I am sure, be glad to give any needed information and to take charge of and forward any photographs entrusted to him.

The Erratic Blocks Committee, although in existence for 21 years, still finds many gaps in the information supplied to them, and complaint is made that from many districts no reports whatever have been received. I fear we cannot claim to have done much to aid this inquiry, and yet a good field for observation and report was open before us. I hope that those of our members (and there are several) who have the requisite opportunity and skill will not lose sight of this work in the near future.

In section D the subjects of the protection of wild birds' eggs and the disappearance of native plants received attention. Among the novel suggestions made, specially in reference to the first subject, was to utilise for this object the teaching of the young in Board and other schools. As regarded the latter, it was reported that the wild maiden-hair fern had been found near Morecambe Bay.

In connection with the question of Museums, the possibility and desirability of having support given to local Museums through the Technical Instruction Acts was suggested, and the suggestion favourably received. The reading of papers on the contents of these local Museums, in their separate departments, was recommended by the chairman, with a view to their being catalogued in the Association lists, and thus brought under the notice of workers in the same subject elsewhere. This would be specially desirable where, as is often the case, the local Museum is rich in the materials *peculiar* to its neighbourhood.

In section F reference was made to the Ordnance Survey maps and to the insertion therein of matters of archæological interest. As there is a new survey of this district at present in

progress those of our members who are experts in this subject will, I doubt not, be glad to take advantage of the opportunity to have all omissions within their knowledge supplied.

In section H the principal subject was the Ethnographical Survey of the United Kingdom. The Chairman of the Conference, who was also a member of this Committee, in especially drawing the attention of the Delegates to its work and the first report, just issued, hoped they would bring it before their respective Societies ; as the kind of work required is essentially local and such as would give greater scope for investigation to the members of their Societies the intention of the Committee is shortly stated in the report as follows :—

"The Committee propose to record for certain typical villages, parishes, or places, and their vicinity—

(1) Physical types of the inhabitants ;
(2) Current traditions and beliefs ;
(3) Peculiarities of dialect ;
(4) Monuments and other remains of ancient culture ;
(5) Historical evidence as to continuity of race."

As a first step, the Committee desire to form a list of such places in the United Kingdom as appear especially to deserve ethnographic study, out of which a selection may afterwards be made for the Survey. The places which appear to them most suitable for entry on the list are such as contain not less than 100 adults, the large majority of whose forefathers have lived there so far back as can be traced, and of whom the desired physical measurements, with photographs, might be obtained.

The entire report, which occupies over 33 pages of close type, shows the energy and success with which the preliminary work has been prosecuted. Already a list of upwards of 250 places in England and Scotland considered suitable for such survey has been made. As regards Ireland, it is stated the matter will be investigated by a sub-committee, under the auspices of the Royal Irish Academy, of which Committee Professor Haddon is the Secretary. From this sub-committee

no report of progress is recorded. But as the announcement of the formation of the Committee, made last year at a meeting of the Belfast Naturalists' Field Club, was very warmly received, I have no doubt this neighbourhood will not be neglectful of the aid which it is so well fitted to afford. The mingling of races from varied sources which, from time to time, has occurred in this part of the country has left indications still existent which may well be sought out and recorded. The same may be said of many other parts of this island, and I doubt not, under the auspices already mentioned, will not be lost sight of. As evidence in this direction, I may mention that at the last meeting of the Royal Irish Academy a paper was read by Dr. Charles R. Browne on the Ethnography of Inisbofin and Inishark, Co. Galway, and has been referred to its Council for publication. The attention given to the subject of "Folk Lore" at the last meeting of the Belfast Naturalists' Field Club also shows that some of its members are on the alert in, at any rate, one branch of the subject. It will, however, readily be seen how much remains to be done, and I would hope that a systematic effort may be made by both the Societies, Belfast either acting conjointly or not in its own sphere, to have adequate returns sent forward from this district.

Among the many subjects upon which papers were read during the Association's meetings likely to be of special interest to the members of this Society, time will only permit me to refer to one or two.

The presentation of the report of a Committee on the Marine Zoology of the Irish Sea showed that important results had been obtained from the district investigated—viz., that which could be readily reached from the Isle of Man—many new species had been obtained. This Committee will continue their work under a new grant.

In the Anthropological Section a very interesting communication was made in regard to explorations of an extensive lake village at Glastonbury. The work appeared to have been done in a very careful and systematic manner. Among the results

there was an extensive exhibition, in cases, of the relics of the former inhabitants. This work also will be continued under a renewed grant.

I cannot close these discursive remarks without at least a simple reference to the announcement which to-day reached us of the death of that eminent man of science who, when the British Association last met here, was its President—Professor Tyndall. It would ill become me, so little fitted as I am to the task, to enlarge upon his manifold claims to regard, respect, and admiration. This will no doubt be fittingly done by many qualified to do it. I shall only add that in him Ireland has lost one of its conspicuous lights.

Professor FitzGerald—With reference to Mr. Tate's report, I do not know whether the members of this Society have had their attention directed to some recent publications on the subject of the glacial epoch. A great deal of information is contained in an article on the subject in the last *Quarterly Review*. With reference to the allusion to Museums, I see that the Chief Secretary has consented to receive a deputation on the 15th inst., with the object of urging upon him the importance of making better provision for technical education in Ireland and establishing a separate department for science and art in this country.

Mr. Wm. Gray alluded to the admirable photographs sent in from Belfast in connection with the geological section of the British Association. Belfast was the first to co-operate with the Association, and near the first to send forward ladies' work. They had reason to be proud of the position they occupied.

Mr. Douglas Lithgow read a Paper on

GOSSIPINGS ABOUT THE PARISH OF SAUL.

Some time ago I intimated to my friend, Mr. Young, that it was my intention to present to the Belfast Museum two old

fragments of stone, which I picked up a few years ago in the Parish of Saul, County Down. I have brought them here with me this evening for your acceptance, and shall feel amply rewarded if you will do me the honour to find them a resting-place in this home of security. I am afraid I cannot trust myself to give an accurate description of them, but feel confident that any technical omission on my part will be fully compensated for by the minute inspection to which they will be subjected to at your hands. Before proceeding further, however, I would humbly claim your kind indulgence to say a few words relative to the early history of this ancient parish and the surrounding district, with which I have been familiar since my childhood. I shall, therefore, ask you to bear with me for a short time, while I endeavour to put before you the few facts which I have hurriedly arranged in the most condensed form, merely to serve as a brief historical outline of a division of the country teeming with research and full of antiquarian lore. Leaving Downpatrick, the representative city of the once famous kingdom of Ulidia, and proceeding in a north-easterly direction for a distance of about one and a half miles, along one of the most charming roads in Ireland, we arrive at Saul; and taking our stand on the little green patch in the centre of the spot where the three roads converge, and looking steadily around on every hand, upon the beauty and magnificence of the scene which presents itself to our view, we can reasonably account for the intense love and veneration cherished by our patron saint for a land so fair and a scene so rare. It may be a source of disappointment to many to find historians differing as they do regarding the place where St. Patrick first set foot on Irish soil. It is a question which has never given rise to any degree of doubt in my mind, since I have closely followed up the line laid down so carefully by Dr. Lanigan (author of the Ecclesiastical History of Ireland), who was fully satisfied regarding Lough Cuan (now known as Strangford) as the place where the saint landed. The late Mr. J. W. Hanna, whose knowledge of Irish history was unsurpassed, and whom I had

the privilege to accompany, times out of number, on little excursions through the bye-ways and lanes of Lecale, published a pamphlet many years ago, from which I cull the following :—"The several lives of the Saint published by Colgan (in each of which the facts concerned are much the same), assert that St. Patrick having proceeded northwards, along the coasts of Dublin and Louth, and passing by the kingdom of the Ultones (formerly Ulidia, now the barony of Lecale), at length penetrated into a certain frith, which is Brénnèse, and he landed at Ostium Slain (the mouth of the slain). There, indeed, they concealed the bark, and they came a little distance into the country, that they might rest there and lie down." Here we are called upon to solve the great problem of identification of Brénnèse and of the Slain, and to set aside the opinions of the majority of those writers who have been in favour of Dundrum Bay, and who seem to have followed the popular belief of those who preceded them, rather than afford us sufficient evidence to prove that they had made a full examination of the facts for themselves. I think if we closely consult the Book of Armagh, compiled about A.D. 807 ; The Life of St. Patrick, published by Colgan ; Harris's History of the County Down, Dr. O'Donovan, Dr. Lanigan, and other writers, we are enabled to arrive at the conclusion that the Fretum Brenesse could be interpreted in no other sense than the present Lough of Strangford. The "Four Masters" write :—"An inundation of the sea over the land at Brena, in this year, which was the seventh lake eruption that occurred in the time of Partholon ; and this is named Lough Cuan." Now, Dr. O'Donovan observes, "This is called Fretum-Brennese, in the second and fourth lives of St. Patrick by Colgan." To my mind the evidence is sufficiently clear that it was the ancient name of the mouth of Strangford Lough, and, that after the inundation, the lake thus formed was called Loch Cuan, now known as Strangford Lough. I will again take the liberty of quoting from Mr. Hanna's notes :—"Sailing down Strangford River, passing Audleys and Walshestown Castles, and steering in a westerly

direction, between Saul and Gore's Island, in a pretty little recess or estuary, you come to the mouth of a small river, having the high foreland of Ringbane (Rin-Ban, the white promontory) to the east, and Ballintougher (Bailean-tochair, the town of the causeway) to the west, which townland forms the extreme land boundary of Strangford Lough. This river rises in Loughmoney, about two miles to the South, and was formerly a tidal river, for upwards of a mile, nigh to the little village of Raholp. Ballintougher was a Government port, included in the Ardglass collection, in the time of Elizabeth, and of James the First. Latterly a battery and flood-gates have been erected at its mouth, for the purpose of keeping out the tide and reclaiming the broad expanse of land at the embouchure. In the taxation of Pope Nicholas, made in 1306, under the deanery of "Lechayll" in the diocese of Down, we find between the church of "Knockengarre," now Walshestown, and the church of Saul—the church of "Balibren." The late Dr. Reeves, in his "antiquities," has been fully able to identify the church with Ballintougher, previously mentioned, on the authority of an inquisition 3, Edward VI., which found Balibren, *alias* Ballintougher, as being of the annual value of £9 7s 2d, and, as then, appropriated to the Cistercian nunnery of Down. No reasonable doubt can exist that the name Brennese is the Latinised form of Brena, entering into the composition of the name Balibren, instances of which frequently occur in the taxation—nor can there be any doubt that the land of Brena, stated to have been overflowed, and the Ballybren of the taxation were identical, and imparted the name to the "Fretum Brénnèse." The river Slainge, or Slan, the mouth of which lies between Ballintougher or Ringbane, has from the earliest times been called the Slaney River. There is no difficulty whatever in tracing it out. It wends its way like a silvery streak from its original source to-day as it did centuries ago. This river can be no other than the Slain, referred to in the "Book of Armagh," at the end of the Brena. It is only one and a half miles from the church at Saul, and, to those who

have investigated for themselves the facts connected with the history of this district, I think there can be little difficulty in arriving at the conclusion that, from the time the saint left the boat, and penetrated into the thick wooded country, to the time of his meeting with the native Irish Chief Dichu, the journey between the place of his landing at the mouth of the Slain and the place of meeting Dichu, fully correspond with every narrative history records on the subject. I will not attempt to tax your patience by reciting what actually took place at the meeting of St. Patrick and Dichu on the sloping hillside at Saul. The spirit of Divine power and love was surely there. The swords and spears of Dichu and his warriors were soon turned into ploughshares and pruning hooks. The light and love of a Divine Spirit had touched our benighted land ; henceforth, all things became changed and transformed. "The wilderness and solitary place was made glad," and when the saint had fulfilled his holy mission throughout the length and breadth of this island, he returned, weary and foot-sore, to Saul, the place he dearly loved, the spot from whence he originally started on his great work, and there he fell asleep in death, and on the 17th of March, A.D. 493, was buried at Downpatrick. Dichu either built by direction of the Saint, or it may be that a building of some kind existed at Saul in the form of a barn, and this the chieftain, after his conversion, gave to St. Patrick. In course of time a church was built by the saint, and placed from North to South. In Harris's History of Down, this church is referred to as "a monastery for canons regular—the first Abbot appointed by the Saint being St. Dunnius. The modern pronunciation of Sabhall is Saul, and the latter Latinised is Saballum, and in the Irish language Sabhall or Savhall Phadrig, signifying "the barn of Patrick." A short distance from Saul, at a little village called Raholp (Rathcolpa), is the church of St. Thassach, the ruins of which are there to this day, having withstood the ravages of time's destroying hand for so many centuries. There it stands in all its loneliness, and is, without exception, the most perfect type of the building of the fifth

century in Ulster. St. Thassach was the chosen disciple of St. Patrick, the first bishop of Saul, who gave "the body of Christ" to St. Patrick, before his death, in the monastery of Saul. The little church of Tassach is about 32 feet long, 20 wide, and stood about 12 feet high. The wall to the south has fallen, and the window in the east end is crumbling to pieces, through want of a stitch in time. The windows are splayed with flat stone lintels, and the material used for bedding the stones is a kind of rough yellow sandy clay. I am inclined to think that some valuable discoveries might be made here, for on tapping the large flat stones, which form a complete fence or enclosure round the foundations, they emitted hollow sounds, as if from a chamber below. It may be of interest to state that the large altar stone, measuring about 12 feet long, 4 feet wide, and in some places almost 8 inches thick, at present in use in the Roman Catholic chapel at Saul, was originally used for the same holy purpose in the ancient church of the parish. Scattered throughout the district may be seen many valuable relics of the past, far too numerous for me to refer to in this short paper. There is a very fine pillar-stone standing in a field at Raholp, with a trace of Ogham characters, and on the face of a large rock, a few paces from the road, on the crest of the hill leading down to the village, may be seen a considerable number of Ogham characters, which, I need scarcely tell you, I never attempted to decipher. We have no reliable information afforded us of what took place in the Abbey of Saul between the fifth and eleventh century, and in order to hurry along I have purposely avoided entering into the ecclesiastical history of Down and Saul. About 1174, a son of the Abbot of Moville, in the "County of Ards," was Abbot of Saul, and a subscribing witness to the charter granted to the abbey of Downpatrick by Sir John De Courcey. In passing I may here mention that Downpatrick is the chief town of Downshire, the only county in Ireland designated a shire, and represents the greater portion of the ancient kingdom of Ulidia. Like many other ancient royal cities it has been subjected to changes,

which seem to have been a common custom in the middle ages. Thus Down is called Dun-leith-glaisse, Drum-leith-glaisse, Dun-da-leith-glaisse, Aras-Keltair, Rath-keltair, Mic-Duach; the fortification of Keltair, the son of Duach, the former name Doun, from Dun, a rath or fort, and finally Downpatrick. It was on this rath or mound, which is one of the largest and most perfect in Ireland, that the native princes of the district were crowned. Mr. Hanna informed me that King Keltair, of the battles, was buried in the centre of this mound, and the large stone cross which was erected over his grave was removed by De Courcey, who set it up in the centre of the town to mark off the English, Irish, and Scotch quarters. The base I discovered in the yard of Denvir's hotel, under the pump. It is at present used as a watering-trough; the shaft is in the possession of the Rev. Father O'Kane, and may be seen any time at the Roman Catholic Cathedral Church. The head is carefully preserved by Mr. W. N. Wallace. There are large portions of the stone cross which marked the grave of St. Patrick to be seen at the old cathedral, the base of which is also used as a watering-trough. In 1526 the Abbey of Saul, with two castles, a garden within the site thereof, and three carucates in Saul and Meritowne (Ballysugah) were granted to Gerald, Earl of Kildare. In 1770 the Protestant church of the parish was erected on the site of the old abbey. There still remains one small vaulted chamber, with a square window and doorway, and a portion of one of the gables about 2 feet thick. Some time about 1870, when extensive excavations were being made for the erection of a large vault, a number of graves were discovered, lined with flagstones, and each containing a number of small white pebbles, similar to those often found in ancient Irish graves. I remember a few years ago, while a farmer named John Fitzsimons was engaged breaking up the field adjoining the graveyard, he unearthed a number of beautifully carved stones, but on my return to the place the following day they had mysteriously disappeared. The late Mr. Samuel Hastings, of Downpatrick, had two well-preserved stone pillar bases,

which he found when making excavations. He pointed out to me on one occasion a mark in the field next the old road, where there was a vaulted chamber still remaining, in a perfect state of preservation, flagged, and a groined roof. There is a well carved stone to be seen, built into the wall at the entrance gate. It is the cover lid of a sarcophagus, ornamented on the edges with a well-defined key, in relief, carved on the face. In the chapter house, Westminster, there is a petition, with the seal of the Abbey of Saul attached. On the seal is inscribed—"S, commune capituli sancti, Patricii de Saballo." The abbot is vested as a priest, sits in a rich chair, holding a cross in his left hand, and raises his right hand, as in the act of giving benediction. The lower compartment of the seal exhibits a bishop holding a crozier. There is a brass seal in the Belfast Museum bearing the following inscription:—"S. Fratris Johannis, Abbatis de Saballo." The two old castles before referred to have long since been demolished, and no trace of them remaining. I will try, however, to localise them. The River Coil—Coile—Quoile—signifies narrow, wooded river, and is derived from the word Cill—Kyle (the Kyles of Bute, &c.). It has, at an Anglo-Norman period, been adorned with no less than twenty-six castles. The townland of Quoile formerly comprised four denominations, viz.:—Cairne-na-grane (the sun's heap), Ferry Quarter, Castle Quarter, and Mill Quarter. Cairne-na-grane still claims its original name and position. The second castle stood on the late Mr Patrick Henvey's farm, at the side of the timber pond; the third on Castle Hill; Ballyhasson (the hill of the cave), Mr. John West's old farm; and the fourth on Mill Hill, at Lower Saul. De Alton's Castle, which is the name of Quoile Castle, is still standing. It was last occupied by members of the West family. At a place called Struell (Strohill, the land of the streamlet) in the taxation of 1306, about half-a-mile from Saul, are the holy wells of St. Patrick. It has been the custom from time immemorial for hundreds of pilgrims to resort to the wells, in order to perform some religious duty and restore their health by bathing

in the waters. The surroundings of Saul will bear favourable comparison with any scenery in the North of Ireland. There you have wood and water, mountain peaks, and lovely valleys, stretching far away in the distance, till we can clearly define upon the horizon the stately towers of Scrabo, Helen's of Bangor, Slieve-Croob, and the Mourne Range. Over against the north-east corner, bordering on the lake shore, stands the high embattled tower of Myra Castle, frowning down upon the peninsula of the Ards, like a mighty sentinel as in days of yore, keeping watch and ward over the most fertile and highly cultivated tract of country in the world. Saul seems to have been the centre of a great ecclesiastical district, even at the time of the Druids. I am led to form this conclusion in consequence of the abundant evidence which the district presents. I find that Slieve-na-griddle (Slieve-gridiron), " Mountain peak of the sun," which is crowned with a large flat stone, is in direct line, or rather at right angles, with Slieve Donard and Slieve Croob ; so, to complete the figure, we have Slieve-gridian in the east, Slieve Donard in the south, and Slieve-Croob in the west. There is a most perfect Druidical temple close to the ancient abbey of Erinagh, or Carnig, in a field at (Laig-na-madda) Ligamaddy (the dog's hollow). The above-named abbey, as you will remember, was demolished by De Courcey, who atoned for his crime by building the abbey of Inch (Inis Courcey), the island church of Courcey, formerly called Iniscumscraidh. He translated all the property of the former to the latter—the three circles—those on the outside for the bards, the second for the priests, and the third for the Archdruids, can be distinctly seen, together with the guard stones, or " bowing stones," in the fields around the temple. I counted forty-eight stones as belonging to it. There is a second temple near at hand on the farm of Mr. Cleland, Ballyalton (" the little cliff"), besides innumerable items of interest, which I must pass over. At Slieve-Croob (" the hill of the cairns ") are twelve cairns, upon which the Archdruids stood when proclaiming the " Brehon," or unwritten law of Ireland. In more modern times Down-

patrick and Saul seem to have had a controlling influence over the great district they commanded, as the whole country is studded over with monasteries; the only two of which any trace remains being those of Inch and Greyabbey. The two old fragments of stone, which I have had great pleasure in handing over to the Belfast Museum, belong to an early age; I should say the tenth or twelfth century. The larger of the two is covered with carving (in relief) on either side. On what appears to be the face of the stone, is a cross and crucifix; on the opposite side, a bishop's key, crosier and mitre. It is about six inches thick, and is carved with fine fluted lines over slightly rounded off corners. Along the top are three half-moon sockets, about 1½ inch deep, which evidently have been intended to fit down upon studs of another slab. The smaller stone has been used for holding the blessed water. You will observe two small lips have been cut on the top edge or rim, for pouring off the contents. On turning this stone upon its face, it presents the form of a cross; hence I am led to believe that the larger stone has formed the top of an ancient Irish cross, erected at an early period in the history of Saul, to mark the sacred spot wherein may have been deposited the remains of some great dignitary of the early Christian church. Here I must humbly apologise for having occupied your time this evening at such length with this hurriedly written gossip about the ancient Parish of Sanl.

Mr. W. H. PATTERSON—The district that has just been referred to is exceedingly rich in antiquarian remains. As regards the two stones Mr. Lithgow has presented, the bowl-shaped one, as he says, is probably a holy water basin, the grooves at the side being made that it might not be filled too full. The other stone seems to be a portion of a raised cross which never had any arms, but the edges of which were decorated with the figures of ecclesiastics. On one face there is a beautiful sculptured cross and on the other a figure of the crucifixion. These stones may probably be referred to the 13th century.

The concluding business of the meeting was of a most entertaining nature, Miss Susan Richardson giving an exhibition of the latest improved phonograph brought from U.S.A. by Mr. Alex. Richardson, Lambeg. With Miss Richardson's clever and skilful manipulation, assisted by her brother, the phonograph delighted the audience with selections by brass and string bands, comic songs, and negro sketches, and so distinct was the reproduction, and so clear the intonation, that the improvements which have been effected in the instrument, the most marvellous example of the genius of the century, were palpably evident.

Professor FitzGerald—I certainly wish to express the thanks of this meeting to Mr. and Miss Richardson for their kindness in coming to-night to give us an exhibition of the phonograph. Some considerable time ago we had a somewhat similar exhibition of an instrument, which was of a very much less perfect description than this. The phonograph has been very much improved of late, and you will agree with me that the one we have listened to to-night is very perfect in its articulation. I may anticipate any formal vote of the meeting by expressing our indebtedness to Mr. and Miss Richardson for the trouble they have taken.

19*th December*, 1893.

Professor Redfern, in the unavoidable absence of the President (Professor FitzGerald), in the Chair.

Mr. Wm. MacWhirter, M.I.E.E., M. Phil. Inst., Glasgow, gave a Lecture on

MODERN ELECTRICAL INVENTIONS.

Mr. MacWhirter, who was received with applause, commenced by saying that, as doubtless the theory and practice of electric lighting had been frequently before them, he did not intend to take up time in dealing with that subject, but would draw their attention to other applications of electricity not so generally known. Looking first at the great question of the electric transmission of power, they found that, although the earliest practical example was not twenty years old, they had now in regular use plant requiring many thousands of horse-power, and at the present time there was a scheme in progress for utilising a portion of the power available in the Falls of Niagara to the extent of about 100,000 horse-power. A first instalment of 15,000 horse-power was in fact being pushed forward with all speed, the working pressure of which was to be 20,000 volts and each turbine to develop 5,000 horse-power. The lecturer then gave a brief history of electric traction, describing the conduit system used at Blackpool, the accumulator system in use at Birmingham, the trollery or overhead system employed so extensively in America, and at Leeds and Walsall, in England, the Lineff system which has been more recently placed on trial at Chiswick, and is so far well spoken of, and the electric rail system as used on the Portrush and the Newry and Bessbrook lines. Having given some figures showing the remarkable manner in which the cost of electric traction

has been gradually reduced and is still getting lower in places where it has been adopted on modern principles, the lecturer proceeded to say that electric haulage was by no means confined to tramways, as there was a large field for its employment in the mining industry. He gave several examples of its successful use in Scotch coal mines, and added that the system was being taken up in several of the English collieries. Electric pumping for mines and other purposes was next explained, and a very complete triple pump in work was shown. The process of drilling by electricity formed the subject of the next explanation and demonstration. An electric drill an inch in diameter being set to work, perforated a steel plate an inch thick in about eighty seconds. The lecturer stated that these drills were being now regularly used in all the Government dockyards, and also by the French and Italian naval departments. All the armour plates on H.M.S. Gibraltar, built by Napier Bros., were drilled by one of these machines. They had been made to drill holes three inches in diameter. Many of those present who had visited the exhibitions in London and Glasgow must have noticed the new process of welding. The system mostly known was the Thomson, where an alternating current of two hundred or three hundred volts is transformed down to a pressure of one or two volts, and capable of giving out currents often exceeding 100,000 amperes. The work capable of being done by this system was, however, limited in extent, as it required 50,000 amperes to weld a steel bar 1·5 in. diameter, and for a bar of copper 0·5 in. in diameter 25,000 amperes would be wanted. The weld was made by clamping the bars to be joined in place, and then bringing them together, when they at once commenced to glow at the points of contact, and the heat increased until the metal fused, when the clamps were made to approach each other by means of a screw until the pressure caused the weld to swell to a diameter larger than the surrounding parts, when the article was removed and dressed by the hammer on an anvil. The Bernardos system was far more capable of general application—in fact could be used in

either the repair of a gold stud or a cast iron fly wheel weighing five tons. The lecturer quoted several cases in which very massive articles had been welded successfully by this system, and gave a practical demonstration of the process in welding together two small iron plates. He added that a number of samples of work executed by this system had been sent on by Messrs. Lloyd & Lloyd, of Birmingham, to be used at the lecture, but unfortunately they had not yet arrived. He suggested that when they did come they might be deposited for a few days in the Museum. The concluding portion of the lecture was devoted to an explanation and demonstration of electric cooking. The advantages of the process were absence from smoke, dirt, smell, or unnecessary heat. With the assistance of Mr. John Brown a number of chops, pancakes, &c., were cooked and submitted to the critical inspection of the audience. In conclusion, Mr. MacWhirter tendered his thanks to Mr. H. Robb, who had kindly given the use of his gas engine ; to Messrs. W. Ewart & Son, who had offered every assistance ; to Messrs. J. S. Brown & Sons, who had given a very large amount of aid from their premises—and particularly to Mr. John Brown, who had contributed so materially to the success of the meeting ; to Mr. J. H. Greenhill, who had helped them materially in the work of preparation ; to the General Electric Company, who had kindly supplied the very complete and elaborate cooking apparatus ; to the Faraday Electric Company, who supplied the dynamo, drill, and other appliances ; and to Messrs. Lloyd & Lloyd, for the samples of welded work to which he had referred.

Mr. George Andrews, in proposing a vote of thanks to the lecturer, said he was quite sure all present would join in thanking the gentlemen mentioned by Mr. MacWhirter, although the very fine display of electrical appliances supplied by their kindness would have been of comparatively little use without the lucid explanation of the talented lecturer to whom they had listened with such sincere pleasure.

Mr. S. F. Milligan, M.R.I.A., seconded the motion, which was passed by acclamation.

On the motion of Mr. GRAY, M.R.I.A., a similar vote was accorded to the Chairman.

The lecture was largely demonstrative, and many interesting experiments were performed in the mechanical application of electric force. A formidable array of electric appliances occupied the platform, including electric pumps, drills, welding machines, cooking, laundry, and lighting apparatus, &c. There was also a large screen upon which diagrams and pictures, illustrative of the lecture, were shown by the hydro-carbon light, admirably manipulated by Mr. John Brown.

3rd January, 1894.

Professor Fitzgerald, B.A., M.I.C.E., President, in the Chair.

Mr. Conway Scott, C.E., Executive Sanitary Officer for the City, delivered a Lecture on

"NATIONAL HEALTH."

Mr. Scott prefaced his lecture by stating that he had chosen for the title of his address "National Health" in preference to the common expression "Public Health," which in these days of statistics had come to have a very peculiar meaning, differing very much from what the words actually expressed, and he used the term health in its widest significance, including not only physical, but intellectual and spiritual health. By national health he simply meant the state of health of the people who constituted a nation, and this state of health could only be measured by the percentage of healthy human beings in the nation. For example, if a nation had 90 per cent. of its people healthy, strong, and energetic, and 10 per cent. diseased, weak, and spiritless, such a nation could confidently be said to have an exceptionally high standard of national health. If a nation had 75 per cent. of its people thoroughly healthy, physically, intellectually, and spiritually, and 25 per cent. diseased, such a nation had also a high standard of national health. If a nation had 50 per cent. of its people healthy in body, mind, and spirit, and 50 per cent. diseased weaklings, such a nation, no matter how high its civilization, how great its national prosperity, or how pure its religion, could not be said to have a satisfactory state of national health. If a nation contained only 25 per cent. of healthy people such a nation, although enjoying the full fruits of civilization and full of glorious institutions for the

relief of human suffering, had a low and dangerous state of health. Through the wide publication of the Registrar-General's returns, the words public health had come to be nearly represented by the birth and death rates. A good state of health, according to this, meant a high birth-rate and a low death-rate. The question was—did those figures give an intelligent or correct representation of the state of the national health? He thought they did not for the following reasons. A high birth-rate was only a sign of national health when the great majority of those births were healthy. A low death-rate usually meant that the average span of human life was legthening, and that the life-preserving appliances—sanitary, medical, and philanthropic—were in good order; but it might also mean that a very large proportion of the drunken, dissipated, and diseased population, and their weak and degenerate offspring, were preserved alive by the efforts of philanthropy, aided by medical and sanitary science. In such a case a low death-rate might also mean a low state of national health. Even the absence of zymotic disease might not on the whole be an unmixed blessing. There was little doubt that modern sanitary science, if allowed full scope to act, could exterminate the cholera, smallpox, typhus fever, and many other epidemic diseases which plagued humanity, but under the existing circumstances of civilized humanity, it was doubtful if such a course would greatly improve the national health. When the propagation of the human species was done by the healthy members of society, and not, as at present, chiefly by the diseased, drunken, and dissipated, then, and not till then, will the extinction of all epidemic disease be an unmixed blessing to humanity. In his opinion the figures of the Registrar-General, although perfectly accurate and most perfectly compiled, did not fully represent the true state of the public health. They rather tended to mislead the public into a false sense of security by proving the public health to be good when it was quite possible that the national health might be in a low and most unsatisfactory condition. For example, according to the

Registrar-General, the district of London, with its high birth-rate and low death-rate, was a most remarkably healthy city; yet what was the fact? The most careful investigation could hardly find a person except a few diseased children among the working classes in London whose parents and grand-parents had been born in London; that meant London killed off its working-class population in three or four generations, and was being continually recruited by healthy immigrants from the rural districts. No matter how favourable the figures, such a city was not a healthy place for the working-class to live in. What was wanted was the Registrar-General to publish a health-rate showing the percentage of healthy and diseased people in the population, then the public could judge at a glance the true state of the national health. Had Great Britain 75 per cent. of its people healthy? had she 50 per cent. healthy? or had she only 25 per cent. of really healthy people in her population? On the answer to this question depended the whole future of the nation. If every century the percentage of diseased and degraded humanity was steadily diminishing, and the percentage of strong, healthy, and energetic people steadily increasing, then the life of the nation was assured and the future was full of hope and promise. The lecturer then took a hasty glance at the prejudicial effects which civilization had exercised on Grecian and Roman national life, and afterwards, referring to the case of the Jews, said that the method by which Moses solved the problem of restoring the national health of a diseased, degraded, and miserable people was masterful in its very simplicity, and consisted in compelling those people to live for forty years in conformity with the highest sanitary laws, and the general scope of those laws might be briefly described, making all necessary allowance for difference in the name and classification of diseases. The entire people were rescued from the contamination of civilization and the impure life of large cities, and removed to the solitudes of the desert and the fine bracing air of the mountains. Cleanliness of every kind was most rigorously enforced in a manner impossible in modern times. Food and

drink were put under lawful inspection, and nothing impure, unwholesome or liable to cause disease was allowed to be used. Every case of epidemic disease was isolated, the house purified, the clothing burned, and every person in contact with the disease isolated until cleansed and purified. In the treatment of such diseases Moses in many respects had anticipated modern sanitary science by about thirty centuries. The first lesson to be learned from the history of the Jews was that no civilization could kill a nation which elected to live according to the laws of God and Nature, and that it was not the civilization which destroyed the human race, but the lawless lives led by people who lived under civilized influences. Modern civilization would not perish because of its scientific triumphs, or its laws, or its literature, or its religion ; it could only perish in consequence of the lawless and unhealthy lives led by multitudes of so-called Christian people. The great hope of modern civilization was that in one form or another all Governments were beginning to realize the great eternal principle that the national health was the supreme law, but the efforts made in this direction were as yet very fitful and elementary, and could not for a moment be compared to the sanitary code voluntarily adopted by the Jewish people. No Government could stand for a year that would dare to propose a thorough sanitary reformation, interfering at every step with the Englishman's much-boasted liberty of the subject, which in plain language meant liberty to be as drunk as they liked, liberty to be as immoral as they liked, and liberty to propagate as much disease as they liked. As long as the public opinion of Britain endorsed such ideas no great improvement could be looked for in their national health, but the moment public opinion determined that the highest liberty was to live according to the laws of God and nature then, and not till then, could they have a marked improvement in their national health. If but for fifty years the Christian public would elect to live in that way they could not estimate the improvement which would take place, and their successors would thank them in a new and improved world, and in order

to understand this let them look with impartial eyes upon the present position of Christian Britain. All the citizens of this free country could drink themselves into all kinds of foul diseases, and their diseased, degraded children filled up the charitable institutions, and a benevolent Government afforded facilities for their doing so as quickly and as easily as possible. Numbers of persons were at large about the streets so thoroughly diseased that their very breath was infectious, and those persons brought into the world year after year whole armies of diseased children for a charitable Government to maintain. In fact, under the present benign Government there was no human being too wretched, too diseased, or too miserable that he could not contract a legal marriage and bring as many wretched and diseased children into the world as he was able to, and the public provided a comfortable existence for all these miserables. He could not but think the number of diseased and degraded humanity was slowly and steadily increasing, and it would soon require an electric lamp to discover a thoroughly healthy human being in this boasted country of ours. It appeared there was hardly such a being as a thoroughly healthy child born into this world, their parents being more or less diseased, and their modern education and examinations were well calculated to destroy the little health that was left. He believed the average health of this nation was twenty-five, and he would like to see the man who would tell him that that was satisfactory. That was no fancy sketch, but a grim and stern reality, as would be seen by considering a few facts and figures which were authenticated. If a drunkard only injured himself the loss to the national health would be but little, but the children were weak, puny, and scrofulous, and often idiotic and deaf and dumb. It was estimated that 50 per cent. of the idiots of Massachusetts were the children of intemperate parents. In the ten years following the reduction of the spirit duties in Norway insanity increased 50 per cent., and idiocy among children 150 per cent. in the same period. As to early marriage, also a prolific cause of disease in children, the last census returns showed that there

were 28,000 wives only 15 years of age and 169 widows of the same age in the United Kingdom. The great problem of the age before which all others, social or political, sank into insignificance was to restore to civilized man his long-lost health. It was by no means unsolvable or difficult of solution, the great difficulty being in their own minds arising from false ideas of delicacy, false ideas of philanthropy, and false ideas of religion. The first great step in improving the national health was to confer the franchise in a liberal manner upon women. Men would never legislate in a thorough manner to curtail his pleasure, though in this way he made whips to scourge whole generations of innocent women and children. Women who were the sufferers would best legislate upon such subjects. Drunkenness must be treated as a crime against the national health, and should be punished accordingly. To sell or give spirituous liquors to any person under 21 years of age, except under medical advice, should be a criminal offence; the marriage of immature boys and girls, and the production by this means of large families of weak children must be abolished *in toto*. The present system of cramming for examinations must also be done away with, and in every public examination health should carry as many marks as classics, mathematics, or English literature. Mankind in every age had formed himself into voluntary associations for many objects—the suppression of slavery, the abolition of the corn laws, the promotion of temperance, and in all those had done useful work in promoting reforms for the benefit of the human race. Now was the time to form a great society, having for its object the attainment of the highest possible perfection of the human race physically, intellectually, and spiritually, and such an association would be of the greatest value in correctly moulding public opinion, in guiding the action of Governments, and generally in promoting the attainment of the highest possible standard of national health. It was estimated that mankind had existed in this globe in some state or other for millions of years, and it was calculated that the world would be capable of human

habitation for some millions of years to come. The history of humanity was a bloody record of crime, misery, and suffering. Was this dismal record to continue for another million of years, or was a new era to commence—mankind every century rising in his health physically, intellectually, and spiritually, until they had a race of human beings full of health and intellect and spirit, as God intended them to be, and possessing a beauty that was Grecian, a grandeur that was Roman, and a spirit that was truly Christian ?

Dr. Whitaker—In the first place I may give expression to the pleasure I have had in listening to Mr. Scott. I am afraid, however, that instead of one lecture he might have given two or three. I would have thought that the subject of physical health would have been quite sufficient. I am afraid Mr. Scott rather trespassed on the ground of the clergy. The education of the present time appears to interfere materially with the physical strength of those coming forward. The younger people are pressed on unduly, and it seems to be a matter of how much they can know in a perfunctory sense without understanding ; how they can answer questions and get through examinations. I confess that I do not agree with Mr. Scott in some of the matters brought forward, though every one he has mentioned requires very great and very serious consideration. At the same time I am not one of those who believe that legislation (even if ladies were members of Parliament) will make people good, happy, prosperous, and virtuous. All prosperity—all national health—must proceed from the people themselves. There is no doubt whatever that woman has a great deal to say to the health of any child, particularly in looking after household affairs. I have been thoroughly astonished occasionally in going through the slums of our city when I have seen one house perhaps in a dozen, or perhaps even two dozen, almost an oasis of cleanliness in the desert. Latterly the authorities are beginning to awaken to a sense of the duties being forced upon them ; they are trying to make people healthier than they were, and although a city

like our own may be prosperous, still there can be no prosperity in any city unless the physical strength and health of the community be preserved and maintained.

Dr. Redfern—I came here fearing that Mr. Scott would have indulged in a number of statistics. I quite anticipated being told that when the death rate had diminished that indicated a very high condition of health, and I am very much delighted to find that Mr. Scott did nothing of the sort. I entirely agree with almost every word he has said. I feel that the subject he has brought forward is one of the most serious importance. He has touched the great causes which produce disease and fill our workhouses and lunatic asylums, and when such things as Mr. Scott has spoken of prevail and corrupt the community in such enormous numbers I see no hope of anything better except by the adoption of some such measure as Mr. Scott advocates against the propagation of disease and the production of poor, miserable, and feeble human beings.

Dr. MacCormac—I came here to-night to absorb not to criticise, and can say that I have not been disappointed in the nutriment. I think that what Mr. Scott has said has been put clearly, forcibly, and truthfully. The points he has touched upon are of the greatest importance; the proportion of the healthy to the unhealthy, and the history of ancient races compared with the people living at the present time. At the same time I would take the liberty of saying that these are subjects which have not been neglected. Thc medical profession has been dealing with these subjects to the very best of its ability, and with very great success. What I would like to have heard from Mr. Scott would have been something of sanitation. This would have been most interesting, because it would have had the effect of perhaps throwing light on the mode by which the diseases of which we have heard could be grappled with. I do not think that because persons suffer from certain diseases they are to be looked upon as loathsome creatures. They could not perhaps have been able to avoid them. Drunkenness is not the only cause of disease. I do not for one moment say that it is a

minor cause. We have typhoid fever, smallpox, and diphtheria. Are all these produced by drunkenness? We want some means to do away with these diseases. What are these means? As a prevention from disease I do not think that even the most perfect water system would accomplish all that is desired. Is there nothing in nature by which she may rid herself of all the contaminations that may occur? I think there is, that there is a fundamental force, an all pervading force which nature herself uses in most important instances, and that force, I hold, is electricity. I speak not as an enthusiast, for at the present time in Havre electricity has been adopted as a purifying agent, and has purified sewers that were seething with pestilence.

Mr. P. C. Cowan—I think Mr. Scott takes a very pessimistic view of his subject. His ideas seem those of the Old Testament, and he appears to forget altogether those of the New Testament, which are later, quite as different and quite as authoritative. I must confess to disappointment that the paper is so abstractly theoretical, and so very impracticable, except towards the end. Note carefully, he attempts to take into account not only the bodily but also the intellectual health. I do not doubt his ability, but I do not understand how he obtains an exact numerical value, such as the 25 per cent. average of national health he assigns to these islands, as it appears quite beyond human powers to measure spiritual and intellectual health. It is possible to make progress by taking as a guide the usual statistics of health, but, in my opinion, quite impossible to make any progress in the improvement of public health by the use of such fanciful measurements as Mr. Scott proposes. Evidently any town, however high its death rate, might claim to have the highest value of national health on Mr. Scott's scale, if there were enough self-conceit in the community, as it might easily be asserted, and who could prove otherwise, "O, though we are dying by scores by all kinds of disease, we make up for and over-balance that by our ability and fine qualities of mind and soul." To a certain extent I agree with Mr. Scott that there should be punishment for

disease, as I believe there was much justice in the opinion of an old teacher of mine that every case of typhoid fever should be followed by a criminal prosecution.

Mr. Milligan—I think one of the factors that tended to advance national health in ancient times was the fact that women engaged more in athletic exercises than they do in the present day. It is the duty of our Town Council to provide open spaces where children can play, and parks for athletic games; and if the people were more careful in their food a higher standard of health could be attained.

Mr. Greenhill—I agree with Mr. Scott's remarks to a very large extent. It has been said that you cannot make a man sober by Act of Parliament, with that I entirely agree; but you can to a very large extent prevent him getting drunk by legislation. I also consider that a parent should be made amenable for sending a child out to the street half-clad. One point strikes me particularly, the matter of infantile insurance. To my mind it ought to be absolutely impossible for any parent to insure his child's life so as to benefit by his death. I think if that were prevented greater care would be taken with regard to the maintenance of the children's health. I won't touch upon the question of purifying sewage by electricity, because it is a subject of which I know very little, but I have no doubt that the experiments which are being carried on at Havre and other places will prove of immense benefit to the large cities where there is great difficulty with regard to the disposal of the sewage.

Mr. Scott—I must thank you for the manner in which you have received my paper, and I consider the compliment paid to me by such a man as Dr. Redfern, a gentleman whose reputation is not only local but European, an ample return for any trouble I may have had. Dr. Whitaker thought that the moral had nothing to do with the national health; I entirely disagree with him. If you leave the moral and the spiritual out, you will have little left. In reply to Dr. MacCormac, who understood me as making some remarks against the medical

profession, I may be allowed to say that there is no one here who has a higher opinion of that profession. We owe very much to the medical men. I like to have an argument with a man like Mr. Cowan. He says it is impossible for me to form an approximate health rate. I think if he will look deeper into the matter, he will find that it is not impossible. I have read reports of doctors upon thousands of school-children as to their condition of health, and have carefully gone into the whole subject, and I am convinced that my estimate is not too low. Mr. Horner has raised the question of the ventilation of sewers, but that is not the subject this evening. Two years ago the subject was discussed here night after night, and it is not necessary to bring it up again. I like the remarks of my friend, Mr. Milligan, about open spaces. Everything to promote the health of the rising generation, such as open spaces, gymnastics, etc., should be encouraged and provided for.

6th February, 1894.

Mr. Robert Llyod Patterson, J.P., in the absence of the President (Professor FitzGerald), occupied the Chair.

Mr. George Roche, of Dublin, gave a Lecture, entitled

THE AMERICAN MAIL SERVICE.

THE LATE MR. JOSEPH JOHN MURPHY.

Prior to the delivery of the lecture,

Mr. Patterson said he regretted that the President of the Society, Professor Fitzgerald, was not present, and in his absence he, as one of the Vice-presidents, took the chair. He was no stranger to that position, as he was President of the Society many years ago, and he could say that, excepting the Chamber of Commerce, there was no room in Belfast in which he felt more at home than in that room in which they were assembled. He regretted that his first duty on taking the chair was to perform a duty that was a very painful one to him in consequence of the nature of the motion he was going to submit for their consideration in a few minutes. And yet, having regard to the degree of intimacy, and friendly relationship that existed between the family of the late Mr. Joseph John Murphy and his own family for a very lengthened period, he thought the motion he was about to submit to them would be considered to come not inappropriately from himself. It would be fresh in the memory of all of them that Mr. Murphy had been called away to another world within a very recent period ; and under those circumstances, when they had lost such an old and valued and prominent member of their Society, it was only right and fitting that a vote of regret should be passed for his departure and a vote of sympathy and condolence conveyed to his relatives. Mr. Murphy had been elected a

member of that Society so long ago as November, 1849, forty-four years ago, and he was for a very short time a member when the usefulness and industry of which he afterwards gave such remarkable instances began to show themselves. He read his first paper before he had been three years a member of the Society. He was elected a member of the Council in 1852, and he continued a member of the Council uninterruptedly from then to the date of his death, last month—a period of over forty-one years. During that time he was treasurer of the Society for a considerable period. He was president on several occasions, and he was one of the three trustees of whom he (Mr. Patterson) regretted to say he was now the only survivor. The other was Mr. William Bottomley, who was called away some years ago, and now he had to regret the loss of his other colleague, Mr. Joseph John Murphy. He had before him a list of papers which Mr. Murphy delivered from 1852 up to 1866, when he lost his wife. His more immediate and active interest in the Society ceased about this time—he meant his active interest in so far as appearing at its public meetings was concerned, but his interest in it as the invaluable editor of its proceedings continued uninterrupted. With these observations, which he spoke under very considerable feeling, he begged to submit the following resolution to their consideration :—" That at this, their first meeting since the lamented death of Mr. Joseph John Murphy, one of the most eminent of our past presidents, the Belfast Natural History and Philosophical Society desire to place on record their deep sense of the loss the Society has sustained in Mr. Murphy's removal from one of the many scenes of his long and useful labours—one where his wide reading, his untiring industry, his love of research, and his ever ready willingness to impart information to others from the wealth of his well-stored mind rendered him for over forty years one of the most valued members. Of him it may truly be said that, while his kindliness of disposition, his broad sympathies, his unostentatious generosity and his many good qualities of head and heart endeared him to to his family and numerous friends, his singlemindness,

unselfishness, and transparent honesty of purpose commanded the respect of all. That it be an instruetion to the Hon. Secretary to forward a copy of this resolution to Mr. Isaac J. Murphy, and to convey to him the sympathy of the members of the Society with him and his family in their recent bereavement."

Dr. REDFERN, in seconding the motion, said Mr. Patterson had known the late Mr. Murphy long before he came to that Society, but everyone in the city who took any interest in physiology, in mathematics, any interest in the welfare of the community in general, had known Mr. Joseph John Murphy. He was sure no one had been more prominent or more earnest in every way in seeking the good of that Society and of every member of the community than Mr. Murphy. It made no difference whether the subject was one which interested a great body of persons interested in natural history, in geology, in the history of the world, in the history of their institutions, in physiology, in mathematics, in astronomy—it was Mr. Murphy's earnest desire to promote as far as he could, and that was to a very much greater extent than fell to the lot of many persons living in his time, the good of those subjects and of the community. He was sure everyone had felt with Mr. Patterson, though not so closely acquainted with Mr. Murphy as that gentleman was, the loss which Mr. Murphy felt by the loss of his amiable wife, and although that loss caused Mr. Murphy to cease attending the public meetings of the Society, he had displayed his interest in a more permanent and more important way even since that time than before in the Society's proceedings. They had lost a friend. They had lost one to whom he was sure everyone could have applied for assistance and advice under any circumstances in which he might be placed, especially in connection with any of the subjects he had mentioned, and he was sure there was no one in Belfast who had ever heard the name of Mr. Murphy but would sympathise deeply with Mr. Patterson, with that Society, and with the family of their departed friend in his removal from amongst them.

The motion was passed unanimously.

Mr. Patterson, in vacating the chair, which was taken by Mr. John Greenhill, the President of the Chamber of Commerce, explained that it had been originally intended that the lecture should be delivered under the auspices of the Chamber, but that it had been thought better those proceedings should take place in connection with that Society.

Mr. Greenhill said he felt it to be quite a privilege to preside in that historic room, where so much valuable information had been conveyed from time to time. He was indebted for that honour to the courtesy of their President and Secretary, and also to the kindness of the excellent Hon. Secretary of the Chamber of Commerce, Mr. Patterson. In referring to the subject for that evening's consideration, he thought he might say that an expeditious and regular mail service was of very great advantage to any community, and to a community of manufacturers and men of commerce it was of very special significance indeed. He had observed, and he was sure they had likewise observed, that in contrasting the advantages of Southampton, and Queenstown London had been very prominently considered as the place to and from which the times of each route should be taken. He did not wish to minimise in any way the claims of London in making calculations with regard to the advantages of one service or the other, but it did occur to him that perhaps there were other districts of England that were to be considered as well as London. He had been informed that a very much larger number of letters passed between the United States and the manufacturing districts of England than between the United States and the city of London. He would therefore urge that in considering the five millions of people in London, they should likewise consider the five millions of manufacturing inhabitants of Yorkshire and Lancashire, and in that connection he thought it would be well if those who were interested in making comparisons with the object of showing which was the better route —Queenstown or Southampton—would also make a comparison to show which of those two routes would be more suitable for, say, Manchester, as the centre of a very important manufacturing

and commercial community. He did not think that it would be wise for him to occupy their time any longer, as they had come there to hear their friend Mr. Roche, whom they cordially welcomed to Belfast.

Mr. ROCHE, who was received with applause, then delivered his lecture, which he prefaced by saying they had heard from the Chairman that not only London but also the various manufacturing parts of England should be considered in deciding definitely which route was ultimately to hold the field. He thought he would be able to show that evening that Queenstown was far and away the better route for the great bulk of the people of the United Kingdom. While Southampton undoubtedly possessed advantages, especially in connection with the passenger traffic, Queenstown was assuredly far beyond Southampton in its advantages with reference to the mail service. He thought they would mostly agree with him that the great object to be attained in the improvements in respect to the mail service which had been spoken so much about during the past year or so was to decide on such a service as would enable the Wednesday's letters from New York to be replied to on the following Wednesday by the outgoing mail steamer from Liverpool, calling at Queenstown on Thursday morning, and Saturday's letters from New York to be replied to by the outgoing Cunard steamer on the following Saturday from Liverpool and Sunday from Queenstown—that was, to have the Saturday's and Wednesday's letters replied to within a week of the time they were sent from New York, and *vice versa*. That was a feat which had actually been accomplished over and over again during the past season by the Queenstown route, not only in the summer months, when the Atlantic Ocean was comparatively calm, but also during the stormy weather of the past few months. There was another fact which ought to weigh with them in the consideration of that question. During the first four or five months of the existence of the Southampton route vessels sailed from both Southampton and New York on Saturdays, the same as the

Cunard steamers from Liverpool and New York, and while that state of things prevailed not in a single instance did Saturday's letters from New York arrive at Southampton in sufficiently good time the following Saturday to allow even the Southampton people to reply to their own letters by the outgoing steamer on the following Saturday, and when the inhabitants of Southampton itself were unable to do that, what could be said of the people in the rest of the kingdom? All that was immensely in favour of the Queenstown route. On a Saturday evening during the past summer, when he was at Southampton, the City of Paris arrived at the docks at 5.30, and the letters conveyed by her reached London at 9.30 the same night, even after the night mail trains had left for the North. The first question the American passengers asked was, "What about the Campania?" which was to leave New York half an hour after their vessel had left, and they were thoroughly disgusted when they were informed that the Campania had landed her mails at 9.30 on the previous Friday morning at Queenstown, and that the letters had been delivered throughout the kingdom on Saturday morning, whereas those brought by the Southampton route were not delivered until the Monday morning. He mentioned that fact to show that, although there had been a good deal of talk about improving the local service between Queenstown and London—and he believed that it should be improved to the utmost extent that the most modern engineering inventions would permit—yet the superiority of the Queenstown route was not dependent upon any such improvements, for at the present moment it was infinitely superior as far as the delivery of the letters throughout the whole of the United Kingdom was concerned. The President of the Liverpool Chamber of Commerce, Mr. M'Arthur, recently said, as far as Liverpool was concerned, the adoption of Southampton in preference to Queenstown would mean that they in Liverpool would have to post their American letters twenty-four hours earlier, and that they would receive their American correspondence ten and a half hours later. That was a very serious difference, and when

they added the difference of the journey from Liverpool to Belfast and compared it with the Queenstown journey, they could easily judge what the change would mean to them in the North of Ireland. There was another argument in favour of the Queenstown route, which might be called a patriotic one, and that was that, while the liners which adopted the Southampton route all sailed under a foreign flag, those on the Liverpool route carried the mails under the British flag, and, moreover, could be used in case of war for the defence of their country. Still another fact to remember was that on the Queenstown route the letters were all sorted between Queenstown and London, while on the Southampton route they reached the General Post Office, London, for the most part unsorted. Mr. Roche threw upon the screen numerous diagrams, contrasting the merits of the two routes. One table showed that, taking the average of eight voyages by the Southampton route, the journey was accomplished in 6 days 19 hours 53 minutes, while the average of nine voyages made by the Campania and Lucania on the Liverpool route was 5 days 15 hours 28 minutes. The Lucania at present held the record for the fastest westward passage, her time being 5 days 12 hours 47 minutes, while the Campania held the record for the best eastward voyage—5 days 12 hours 7 minutes. After exhibiting views of the Teutonic and Majestic, which were received with applause, the lecturer said when it was borne in mind that those fine vessels had been seven years longer on the service than the Lucania and Campania, and that they had never been beaten by more than three and a half hours, notwithstanding the enormously increased horse power of the Lucania and the Campania, he thought they might practically say that up to the present the Teutonic and Majestic were unbeaten as splendid specimens of Transatlantic liners. One of the chief weapons used by the Southampton people was misrepresentation; they stopped short of nothing which would in any degree favour the Southampton route; but, notwithstanding all their efforts, it could easily be proved that the Queenstown route was much superior for the carrying of the mails, for letters

posted in any part of England could reach New York quicker by that route than by the steamers from Southampton, and even letters posted in Southampton itself could be despatched at a later hour by the Queenstown route, and yet arrive at their destination as soon or sooner. The transmission of the mails from Queenstown to London had been accomplished in as short a time as thirteen hours twenty minutes, although the distance covered was 516 miles including sixty-four miles of water, and he believed if the postal authorities could be prevailed upon to adopt some quicker method of loading and unloading the mail bags that time could be considerably reduced. Mr. Roche exhibited several views illustrative of the journey from Euston to Queenstown, and others depicting the arrival and departure of Atlantic liners by both routes. Alluding to the benefit derived by Ireland in consequence of American visitors disembarking at Queenstown instead of proceeding direct to Liverpool, he strongly advocated the adoption of some system of through tickets, which would give travellers the option of sailing all the way to Liverpool, or, without any further cost, of proceeding by rail from Queenstown to Dublin, instead of the present system, under which those who chose the latter course had to pay extra for the privilege. In concluding a deeply interesting lecture, Mr. Roche said he thought from the facts he had placed before them the audience would be able to form some idea of the importance they ought to attach to the question of the Queenstown mail service.

The lecture was much enhanced in value and interest by over a hundred original lime-light photographic views taken by Mr. Roche, including several large pictures of the Teutonic, Majestic, Lucania, and Campania.

Mr. Herbert Lanyon, in moving a vote of thanks to Mr. Roche for his lecture, said what struck him as a very important thing was that such vessels as the Teutonic, the Majestic, and other large vessels which sailed under the English flag could be utilised by the English Government in case of war for conveying their troops from one part of the kingdom to another, and

therefore they should be subsidised by the English Government as far as possible. The captains of these vessels were naval reserve men, and if the English Government subsidised ships that sailed under the American flag they would be subsidising ships that might be the ships of the enemy in case of war. He though that would be a serious matter, and as Britishers they should do all they could to have their mails carried under the English flag. Another matter of importance was the large number of passengers that would be landed at Southampton if it were selected as the mail route. He thought it would be a great injustice to Ireland if American passengers, who spent a large sum of money yearly as tourists in going through Ireland, were carried past Queenstown and landed in England. That would be a grievance of which they would have more cause to complain than many of the imaginary grievances that people talked so much about.

Mr. F. D. WARD, J.P., in seconding the motion, which was passed, said the lecture to which they had listened could only do good, and he hoped the result of it would be that the Queenstown route would be ensured to them for the conveyance of the American mails.

The lecturer, in acknowledgement, said he was not interested in any of the companies that were concerned in the question of the mail service.

The proceedings then terminated.

6th March, 1894.

Professor FitzGerald, President of the Society, occupied the Chair.

Mr. Robert Patterson, M.B.O.U., Honorary Secretary of the Ulster Fauna Committee, contributed some Notes on

THE OCCURRENCE OF THE MARTEN (MARTES SYLVATICA) IN ULSTER.

He gave particulars of the discovery within the past few years in the vaiious counties of Ulster. In County Down one of the most recent discoveries was in 1891, at Finnebrogue, near Downpatrick, which had been stuffed, and presented to the Museum by Major Maxwell. In October of the the same year another was caught near Bryansford, which was also on view. This specimen seemed to have been trapped before, as one of its legs was gone. He had not been able to obtain any recent records of the presence of the Marten in the Counties of Armagh, Monaghan, Londonderry, and Tyrone. He would be glad to hear of any other appearances of this somewhat rare animal in the different counties of Ulster.

Mr. R. M. Young read some Notes on

A RECENT FIND OF IRISH ELK BONES IN BELFAST.

He said in connection with the great system of main drainage which was now approaching completion, under the able superintendence of Mr. J. C. Bretland, M.I.C.E., the city surveyor, excavations for an intercepting sewer were made in

January of this year. Under the footpath on the east side of High Street and Castle Place a quantity of human bones were dug up, opposite St. George's Church, where the burying ground of the previous Church of St. Patrick extended, but it was not until the workmen reached Castle Place that anything of special interest was found. On January 18th an intelligent working man brought him three jaw bones, which had been taken from a depth of seven feet under the footpath, at Mr. Watson's shop, No. 10 Castle Place. Prof. R. O. Cunningham, M.D., kindly examined these bones, and pronounced them to be those of an Irish elk, horse, and sheep. Opposite Messrs. Hart and Churchill's shop quite a number of jaws of the Irish elk were turned up, with some fragments of leg and rib bones. These were associated with branches of trees, probably willow, and were six feet ten inches under the surface of the flags of the footpath. Mr. S. F. Milligan, M.R.I.A., secured some bones, apparently of the horse and dog, which he has kindly presented to the Museum. The Museum's specimen of the Irish elk surpassed in size the largest living deer. Its antlers were sometimes eleven feet from tip to tip, while those of the moose were only four feet. The most recent discovery of Irish elk bones seemed to be that described Mr. R. L. Præger, B.A., M.R.I.A., on February 16th, 1892. They consisted of a skull found in the preceeding December in excavating near the Spencer Basin. It was in the centre of a peat bed, three feet thick, with a depth of thirty feet of estuarine clay above. On the same bed of peat at the Alexandra Dock bones of the deer and wild boar occurred. The present find of Irish elk bones seemed to be the first to be noted within the city boundaries. These bones were lying almost on the surface of the estuarine clay or sleech, and the Irish elk, horse, and sheep bones were found close together, as if either swept down by some flood or possibly deposited in such by human agency. This latter supposition was strengthened by the remarkable appearance of some of the larger bones, which apparently had been broken into short lengths to extract the marrow. They resembled in this

respect the bone so treated by the cave men and the Swiss lake dwellers. In 1868 a similar find was made near the Broadway Factory, and amongst the bones then found were some of the red deer, which had artificial markings, where the flint tools had been at work. Another recently discovered relic of the past was the supposed canoe, which was cut through in driving sheet piles at the waste ground close to the Albert Bridge, where some works in connection with the main drainage had been going on. He and Mr. Lavens M. Ewart visited the place in December last, and saw at the depth of ten feet the trunk of an oak tree, four feet in diameter, which had been burned out on the upper side like a canoe. The part which was cut out by the piles measured six and a half feet long, by four feet wide and three feet deep. The thickness of the sides was not more than six inches, and the wood was sound in the middle. The two extremities of the tree was undisturbed in the sleech at that time, but he understood that one end had been laid bare, and it forked off into two branches. As the other end was still uncovered, it might show visible signs of a canoe in process of formation if laid bare.

Professor FitzGerald apologised for having to leave the meeting, and

Mr. W. H. Patterson presided during the remainder of the meeting.

Mr. S. F. Milligan read a Paper on

IRISH ARCHÆOLOGY.

Mr. S. F. Milligan, who was cordially received, said—It is not the first time I have had the privilege of addressing this society on Irish archæology. On the present occasion I propose to deal with the mode of living, culture, and social customs, illustrating the every-day life of the people in ancient Ireland. Before the Christian era this country had advanced so far as to possess a

code of laws, a regular government, orders of learned men, and public schools. After the introduction of Christianity these laws were revised to suit the altered conditions of society, and for over one thousand years after, with very slight alterations, these laws called the Seanchus Mor, were those which ruled the lives and liberties of Irishmen, and by which they were governed. In the early Christian period the island made great progress in religion and culture, so much so that it became known as the Island of Saints. During this golden age of Irish history for a period of over 200 years, commencing with the early part of the 6th century, the country produced a host of Christian missionaries, whose names became well known over Western Europe, and caused Irishmen to be loved and respected wherever they went. They were known abroad as Scots of Erin, though they themselves prefered to be called Gaels. After the invasion of the Northmen and their kindred, the Normans, religion and progress received a serious check. Men had to turn from the arts of peace to those of war, with all its train of attendant evils. During the peaceful period from the year 600 to the middle of the 9th century, Irishmen were unequalled in the art of illuminating manuscripts, whilst her learned men were advanced in all the essentials of a liberal education. They understood Latin, Greek, and even Hebrew, were thoroughly read in the sacred scriptures, and it was probably from their love of Holy Writ that they spent all their artistic genius in illuminating its pages so profusely, They were well versed in mathematics and astronomy as then known, and some had advanced views on the latter science much ahead of their times. To the great schools of Armagh, Clonard, Durrow, Clonmacnois, Bangor, and Moville, flocked thousands of youths, many of noble birth, who came from Britain and Gaul, so celebrated were these ancient Irish seats of learning. The insular position of the country saved it for a long period from the dark cloud of ignorance that spread over the rest of Europe after the downfall of the Roman Empire, until the northern hordes arrived, who were quite as much at home on sea as on land. They ravaged the monasteries, carrying off the sacred vessels,

manuscripts, and everything they could take they destroyed. To form a correct idea of a Celtic monastery you should exclude from your minds everything you have read or seen of Gothic Romanesque architecture, such as the ruins of monasteries like Adare, Quin, Holycross, Mellifont, Jerpoint or Greyabbey. These were all Anglo-Norman, not Celtic. The Celtic monastery consisted of a collection of circular, wattled, or stone beehive huts surrounded by a circular eastern rampart called a rath, or a huge dry stone built wall, 10 or 12 feet thick, called a cashel. Each brother had a separate little hut or cell, in which he studied and slept. The students constructed similar huts or booths, which assumed the form of a village. Those who were able paid for their food, and those who were not received their support from the people of the district. It was in schools like these that Columba, Columbanus, Galus, Colman, Adamnan, and others were educated, who became great missionaries and teachers, and preached the Gospel to various European nations. From the peculiar habits and traditions of the Irish race, architecture at that period had not attained that position to which it was entitled, and to which at a later period it reached. No doubt the round towers were erected about the end of the time we are referring to, and for graceful proportions and excellent workmanship stand unequalled. It would seem that the men who built them were capable of doing work of a much more elaborate kind. In the 11th century the Irish did direct their attention to the erection of better churches, and such as Cromac's Chapel and Queen Dervorgille's Church at Clonmacnois, both built by native workmen. They invented a peculiar style of stone roofing, unique in its way, and almost indestructible. English writers who dispute our claims to a higher culture and earlier civilisation than theirs generally ignore reference to the remote ages, and point to the condition of Ireland in the Elizabethan age in proof of their statements. It is well known that the decadence of the country had reached its lowest point at the close of the Elizabethan wars. The social condition of the common people was deplorable, being hunted to the woods like wild

beasts, without food or shelter. Is it to be wondered at if they were taunted by being called savages? The state of Munster after the wars of Desmond, and of Ulster after those of O'Neill, show to what depths of suffering and misery the mass of the people were reduced—as tillage had been totally neglected, and no security for property existed. A thorough knowledge of the manners and customs of the Irish people, as well as an aquaintance with the code of laws by which Ireland was governed for such a lengthened period, would have been invaluable to English statesmen legislating for this country. It has been to the utter want of such knowledge in the past that Ireland has not been assimilated more thoroughly with England. Whilst the words of many Continental languages have been absorbed into English, it is remarkable how Irish words have kept coldly aloof, or have not formed any portion of that tongue. We need not push these ideas further than to express an opinion that archæology and legislation could have been associated with advantage to the nation. No European nation can show so many ancient manuscripts relating to remote times as Ireland. These deal with every possible subject. There are copies of the Brehon Laws, innumerable tales and poems of the early heroic ages, written in the Homeric style, together with such works as the "Annals of Donegal," by the Four Masters; "Annals of Ulster," of "Innisfallen," of "Clonmacnois," the "Chronicum Scotorum," &c. These works were written by professional historians, to whom the severest penalities would attach if they falsified them in the slightest degree. No people, with the exception of the Jews, were more careful to transmit accurately their genealogies and history. The ollamh, or historian, did not receive his degree until a period of from nine to twelve years had passed in the closest study and the most severe tests. The French Government in the year 1881 despatched an eminent professor of Celtic to this country to examine and report on our ancient manuscripts. In his report, published afterwards, he stated there are fully 1,000 Irish manuscripts still existing, many of them of great bulk, and very many which had not yet been translated.

In addition to those in the Dublin libraries, the British Museum, and the hands of private collectors, there is scarcely a first-class Continental library that does not possess copies of our ancient manuscripts, carried from this country by Irish monks from the sixth to the tenth century. The Bardic schools were next referred to, and the mode they adopted and other interesting details of their system of teaching. These schools were in existence as late as the seventeenth century. The schools, taught by the monks, as distinguished from those taught by the bards, were next referred to, and the great success that attended these ancient seats of learning. The lecturer gave a translation from the Latin of a poem written about the year 820, by an Irishman who travelled in Italy, and became a bishop near Florence. As it refers to Ireland of that remote time it is worth repeating :—

"Far westward lies an isle of ancient fame—
The best of countries—Scotia is her name.
An isle enriched with an exhaustless store
Of gems, of garments, and of golden ore.
Her soil prolific teems with native wealth,
Her air breathes mildness, and the gales of health.
Her verdant land with milk and honey flows,
And nature here her choïchest gifts bestows.
Her cultured fields are crowned with waving corn,
And art and arms her envied sons adorn.
No savage bear with lawless fury roves,
Nor ravenous lion, through her peaceful groves
No poisonous reptile wounds, no scaly snake
Twines through the grass, nor frog annoys the lake;
An island worthy of the Scottish race;
In war illustrious and unmatched in peace."

Last week, in Dublin, Dr. Sigerson, of that city, delivered a lecture, entitled "The First Saint of Erin." Most people, if asked who he was, would probably reply, St. Patrick; but it was not he to whom the learned doctor referred, but a saint very slightly, if at all, known to Irishmen until brought forward now to the light of day. The learned doctor said he was called Sedulius, lived before St. Patrick, when Nial of the nine hostages was king. He travelled to Britain, Gaul, Italy,

and finally reached Greece. He was a bard, and from his great ability was elected to be professor of rhetoric at Athens. Here he became acquainted with a Christian priest called Macedonius, who converted him to Christianity. He afterwards wrote a beautiful Christian epic called "Carmen Pasquel," an Easter ode. Many copies of this poem were made until the art of printing was invented, when it was first printed at Leipsic, and since that time fifty-one editions of it have been printed. This is a very striking illustation of the learning of the Bardic order in Ireland before Christianity became the religion of the State. He could multiply instances of Irishmen attaining high positions for their learning on the Continent. The Emperor Charlemagne appointed two Irishmen to take charge, one of the great school in Paris and the other in North Italy. The writer who records this refers to them as "two Scots of Hibernia" incomparably skilled in human and divine literature. An Irishman named Feargall about the year 748 taught a school in Bavaria. He held the opinions that the earth was a sphere, the existence of the antipodes, and diuranal motion of the earth on its axis. I need scarcely say these views were quite unknown on the Continent at the time, and he was reprimanded by the Pope for holding such views. Previous to the introduction of the present system of National education there was scattered over Ireland, even in remote districts, good classical and mathematical teachers, and it was no uncommon experience to find a barefooted boy whilst herding cattle reading Latin. The lecturer next described the kind of houses the people dwelt in, the earliest form being circular, with cup-shaped roof, and the fire in the centre of the floor. The people were pastoral, living mainly by flocks and herds, not tilling much of the ground. The dress and weapons were referred to, as well as the mode of living of the chiefs and people in the middle ages. The houses of the chiefs during the Tudor period were constructed of huge frameworks of timber, filled in with clay, and covered with thatch. Later again, during the reign of James the First, what were called bawns were built—a stone house or castle, and attached a

large quadrangular enclosure with towers at the angles ; this enclosure was intended to protect the cattle. The people were extremely hospitable in all grades of society. The chiefs kept an open house, the banqueting place of the clan, or, as the bards delighted to style it, "An open-doored festal gift-bestowing, white wattled lime-washed pile, in which mead and metheglin flowed without stint." In return the kings and chiefs when making a tour through their territory lived on the members of the clan. This was known as coshery, and originated in the righ, or king, collecting his cess or rent. The Norman barons continued this Irish custom, and the coshering visitations made by Ormond, Kildare, and Desmond so late as the middle of the 16th century is described in a state report of the time as follows :—"These earls, with their wives, children, and servants, do use, after the custom of Irishmen, to resort with a great multitude of people, to monasteries and gentlemen's houses, continuing there two days and nights, living at their pleasure, and their horses and grooms are maintained by the neighbouring farmers ; so as they be found in this manner in other men's houses more than half the year, and spare their own. Gerald, eleventh earl of Kildare, on such occasions travelled with a train of 500 horsemen, who were quartered on the farmers of the district. As an example of the prices of food, the following is copied from an old tract written in 1589 :—A barrel of wheat, or a barrel of bay salt containing three and a half bushels Winchester measure, is sold in Ireland for four shillings ; malt, peas, or beans, for two and fourpence ; oats for one and eightpence ; a fresh salmon, worth in London ten shillings, for sixpence ; twenty four herrings, or six mackerel, six sea bream, a fat hen, thirty eggs, a fat pig, one pound of butter, or two gallons new milk, for one penny ; a red deer without the skin, for two and sixpence ; a fat cow, thirteen and twopence ; a fat sheep, one and sixpence. There be great store of wild swans, cranes, pheasants, partridges, heathcocks, plovers, green and gray curlews, woodcocks, rails, and quails, and all other fowls more plentiful than in England. You may buy a dozen quails for threepence, a dozen woodcocks

for fourpence, and all other fowls rateable. Oysters, mussels, cockles, about the sea coast are to be had for gathering in great plenty." A very interesting description of Ireland about this time (1588 to 1589) is given in a letter written by a Captain Cuellar, a Spaniard. His vessel, with two others belonging to the Armada, were wrecked on the coast of Sligo, and he escaped, and travelled through a portion of Leitrim, Fermanagh, and Tyrone until he reached O'Cahan's Castle, at Limavady. He did not remain their, but ultimately escaped from the coast, at or near Dunluce, from whence, with other Spanish refugees, he reached Scotland, and ultimately Antwerp, where he compiled this letter of his travels through Ireland. As to the mode of living he says—"The people live in huts made of straw, the men are big-bodied, with handsome features and limbs, active and nimble as roe deer. They eat but one meal in the day, and that at night. Their usual food is butter and oaten bread. Their drink is sour milk, having none other. They do not drink water, which is the best of all. They dress, after their fashion, with tight hose and short coats (sayas) made of coarse goat's hair. They cover themselves with cloaks, and wear the hair down to the very eyes. They are great pedestrians, and very enduring as regards fatigue. They are continually at war with the English, who hold garrisons near by in the Queen's service, and from whom they defend themselves, not allowing them to enter their territory. They sleep on the ground on freshly cut rushes full of water and frost. The most of the women are very handsome, but ill arranged (tothery) wearing only a shirt and a cloak, which covers them entirely, and a linen cloth which they double closely about the head, tieing it in front. They are very domestic, and very laborious after their fashion. These people style themselves Christians, and mass is said amongst them, their ritual being that of the Roman Church. Nearly all their churches, monasteries, and hermitages have been pulled down by the English garrisons, and the natives who have joined them, and who are just as bad as the English ; so that finally in this kingdom there is no justice or reason, since that

everyone does according to his will." I cannot afford space to give any more of Cuellar's narrative, which is of great interest. Reference was next made to the various orders or grades of society in Ireland, marriage and other customs. The musical culture of the Irish, the old airs, and different instruments of music were mentioned. In Celtic Ireland a harper's person was sacred wherever he went. They had peculiar priveleges and immunities, which were recognised over the whole island, were received and treated with the greatest hospitality wherever they went by all classes of society. Every king and chief had his bard. On the 12th of July, 1792, the last meeting of Irish harpers was held in Belfast. At this meeting only ten harpers could be collected in all Ireland. They played all the old airs as they had been handed down to them from time immemorial. The music was written down by Edmund Bunting, and thus saved from being totally lost. A great social function in ancient Ireland was the Aenachs, or fairs. Here the people met from every district in great numbers. They were somewhat like the Grecian games, and lasted in some instances for several weeks. They were originally instituted in memory of the death of some great king or chief, and were held to commorate his memery. Horse racing, chariot racing, running, wrestling, and various games were celebrated before the assembled people of the district. Prizes were given to the successful competitors. These games in later periods had become known as patterns, but owing to the drunkenness and other causes, the clergy have almost suppressed them. It was at these fairs that the boys and girls met and matches were made, and they were looked forward to with the greatest possible interest. It would be impossible to condense in a small space anything but the merest outline of our ancient social customs, the laws relating to the various classes of society, their duties and privileges. Each grade of society had their rights and privileges regulated by law, from the king to the labourer ; laws regulating the settlement of the land between the various tribes and families ; laws concerning gifts, aliens, loans, pledges, and securities ; for instance, any tool by which a

person earned his living could not be kept in pledge. The fees of doctors were regulated by the old laws, and the position and way the doctors house should be built was stipulated. The fees of lawyers and teachers were stipulated, and a series of laws relating to weaving, spinning, brewing, and building, landlord and tenant, master and tenant. These laws are all in existence since the fifth century, as they are now and were in existence centuries before that in probably a slightly different form. The colonists which landed on these shores from Egypt, Greece, or Spain brought with them an advanced civilisation, from which sprung the ancient code of laws, bardic schools, orders of learned men, poets, musicians, and historians. We Irishmen are deeply indebted to such men as Dr. Petrie, Bishop Reeves, John O'Donovan, and Eugene O'Connor, as well as others, for unravelling the tangled skein of Irish history from manuscripts, the oldest in Europe, from buildings hoary with the lapse of centuries, which show the position our country held in religion, learning, and culture in remote times.

Messrs. W. Gray, W. Armstrong, and the Chairman offered a few complimentary remarks on the the papers.

Messrs. Young and Milligan having replied,

The proceedings terminated.

3rd April, 1894.

Professor FitzGerald occupied the Chair.

Professor William Knight, LL.D. (University of St. Andrews), delivered a Lecture on

THE HIGHER EDUCATION OF WOMEN.

The Chairman, in introducing the lecturer, said the subject was one of which he thought they heard a good deal, and he was sure it would be of great advantage to them to hear the opinion on the subject of Professor Knight.

Professor William Knight, who was cordially received, began by dealing with the subject historically. He said it was a mistake to suppose that the higher education of women had been exclusively or mainly a modern achievement. It was distinctively of modern interest, but they had evidence of the higher education and of many notable successes in philosophy, letters, and art amongst the women of the ancient world. Even in the fragements of early Indian literature women were introduced as taking part in philosophical discussions, but it was amongst the Geeeks that they found the most conspicuous results in this as in so many other directions. The manifoldness of the Hellenic culture would lead them to expect what they actually found—that there were women in Greece more highly cultured than any of whom they had authentic record in mediæval times. Throughout the middle ages they found the condition of women a sad chapter in their history. The shadow of mediævalism was darkest as it bore upon them. If in those times the education of men was slight, that of women was practically non-existent. It was hard to say, however, what might have happened had the Hellenic and Hebraic elements

blended at an earlier period. Modern history would have been very different from what it had been if the leaven of the East had passed over to the West and entered the European mind in a natural manner at the commencement of the Christian era. They knew little about the position of women in England at the commencement of our authentic history, but it was clear that in the early Celtic nation it was on the whole a degraded one. She was simply one of the household chattels, useful as a drudge, or useful to the tribe as its flocks and herds were useful. Its was not to the Celts but to the Saxons that they owed the germs of that regard for women which (when allied with later Teutonic and Norman elements) grew into a chivalrous devotion to them, which had become the parent of so many virtues in man. The Teutonic race, which overran the Celtic aborigines of Britain, showed a regard for the women of their tribes far in advance of anything they found in the most highly-civilised nations of antiquity. No doubt amongst the Hebrews, the Greeks, and the Romans there were exceptional instances of chivalry, of rare tenderness, and high-minded devotion, but that was not the same thing as the chivalry of the Saxon and the Teuton. The Saxon women possessed property and land, and they could transmit or bequeath it, while they often took part in the Witenagemot of the King's Council. Of course the great mass of the peasant women had plenty of hard work to perform, but the Saxon workwomen were not compelled to undergo servile toil, which the Celtic women underwent. In the schools established by Benedictines girls were taught, as well as boys, side by side in the Benedictine abbey, and a part of it was the school where women learned Latin if they chose. The Abbess Elfleda, of Whitby, and Eadburga, the Abbess of Minster, were correspondents of the most erudite men of their age, and their learning was as conspicuous as their charity and devotion were. As time went on the new elements blended with the old, and when they reached the thirteenth century they found a fresh type of chivalry evolved in England, and grafted in the old Saxon stem. When the strife between the Anglo Saxon and

the Norman ended new national characteristics arose out of the welding of the two races, and as one result they saw a different attitude towards women. What more immediately concerned them, however, was the education of the women of that period. At the convent schools, such as the Abbey, Barking, the priories of Clerkenwell, Halliwell, Kilburn, &c., female education was given not only to the nuns, or those destined to be nuns, but to all women of the noble houses and to those of the middle classes who desired it. It was a fact not generally known that in the middle ages women were not cut off from the higher education so much as they were after the Reformation. The records that survived of the educational methods employed at the close of the mediæval period and the commencement of the modern were very fragmentary. Some had supposed that in the sixteenth century a classical education was within the reach of English girls. It was true that there were some highly educated women in England then, but such instances as those of Lady Jane Grey and the Countess of Pembroke, for example, were instances of quite exceptional women exceptionally trained. After enumerating some works which had been written by learned women of the eighteenth century, the lecturer went on to deal with the question of education in America in the beginning of the nineteenth century, and of the number of colleges which had been opened for the conjoint education of man and woman. He then alluded to the opening of several schools of science in Ireland, and dealt with the question of the admission of women into these schools. In 1878 the University of London took the very momentous and decisive step of opening up all its examinations and degrees to women. It was a most significant act, and had been fruitful of good in many ways, reacting even on the educational institutions of America. In the following year Dr. Barnard, the president of Columbia College, N.Y., in his annual report to the College, advocated a similar opening up both of the classes and examinations of his College. But the question was left open, however, whether the students of both sexes should be admitted to the same lectures,

or whether an annexe should be established, where women were educated in different rooms from the male students. The question now arose as to whether the education of men and women was best carried on jointly or in separate colleges each by themselves. The advantages of mixed education were numerous and obvious. There was—First, the same standard of teaching and examination ; second, the distinct economy of having only one staff of teachers ; third, the stimulus of a healthful rivalry in learning between the sexes ; and fourth, the greater likelihood that similar chances might open up to both in the after race of life. On the other hand, there were plain physiological difficulties arising out of differences in organisation and bodily strength that told the other way. It was for that reason he thought that, while mixed classes should remain the rule in the provincial colleges of the country, there would always be some women who preferred separate instruction in colleges of their own, and for whom education on the lines of Girton, Newnham, and the Oxford Halls was much better than anything they could learn in mixed classes could ever be. It must also be remembered, that the mixed system might develop an unhealthy as well as a healthy rivalry. If women began to think it one end of education to outstrip the other sex if possible in every line of effort immense evils would result, and a reaction hurtful to themselves must set in whenever the idea of rivalry became dominant. There should be some colleges exclusively for men, others exclusively for women, others mixed, and open to both, and others open indiscriminately to all. The differences which existed in our social strata necessitated differences in our educational methods as well as in our educational material. It was to be hoped that the recent successes in examinations, over which the whole educated world rejoiced, would not lead many to draw the illogical and extravagant conclusion that all spheres should be opened up to women. Such a result would first injure women themselves, and then react injuriously on men, for the gentler a woman was the more she despised an effeminate man, and the stronger a man was the more he disliked a masculine

woman. The only drawback to the higher education of woman was the risk of increasing their individualism, and in consequence their self-assertion. The purely communistic feeling, the sense of the organic unity of the race, the glory of living for great causes and sinking oneself in the advancement of such causes—those were not always fostered by opening up pathways to learning to which people might isolate themselves till they became the most learned of their age. In conclusion, he said he believed they were as yet on the threshold of triumph as to the education of women, because he believed the more thoroughly educated women were the more thoroughly improved and educated men would be, and therefore the more elevated and ennobled the future of the race would be. He was confident that the higher education of the woman would develop and evoke the virtues of chivalry, of courtesy, and of unselfishness in men, because he was sure of this, that the most-highly educated women, who were trained in knowledge, who became experts in language, philosophy, science, and art, would exert the highest and the deepest, and therefore the most benign. influence on the education of their sons and daughters, and consequently of the whole future of the world.

Dr. Redfern.—The thoroughly exhaustive account which has been given us of what has been done in all time, and especially of recent years, to promote the education of women prevents anything of importance being added. I was extremely glad to hear, what I dare say many of you knew, of the numerous successes of ladies in the Cambridge and London University examinations, examinations, I believe, of the very highest type in arts and science. Mention was also made of what has happened on this side too. Ladies have not unfrequently taken a very high—nay the very highest—place in particular subjects at the examinations of the Royal University. All its prizes and degrees are completely open to women, and have been taken with great advantage by large numbers of ladies, several of whom have altogether headed the men of their year. Something was said by the Professor on which I wish to say a

word as a physiologist. I was afraid when he drew your attention to a very patent physiological difference in the sexes that you might go away with the idea that this was disheartening to women. Though it happens that women are for the most part weaker, in our condition of society, than men, I know no Physiolgical reason why it should be so. I do not think it is so to the same extent with women over the world. It is not so in all women, even in this country, but what we do know is this, the sacrificing nature of women. They sacrifice themselves for their families or husbands, often taking little or no food, and saving most of it for their husbands when they come home. This is not likely to lead to health of body or strength of mind. If women regulated their diet, the times and quantity of it, their amusements and exercises, as men do, they would be much stronger than they are. You heard from the Professor his doubt, and I do not wonder at it, whether it is desirable that men and women should be taught together in joint classes. I think he put that very fairly before you. I know something of this matter in connection with the classes in the Queen's College here, and I am bound to say that in point of gentlemanly conduct, in point of reverence, and attention, no men in the world could possibly have distinguished themselves more highly than the men of the North of Ireland, when taught together with women in the classes of the Queen's College. I am sure you will join with me very heartily in proposing that our thanks be given to the learned Professor for having brought this subject so lucidly before us.

Miss Tod.—It would not be easy for me to express the pleasure which it gives me to second the vote of thanks. The beauty of the lecture to which we have listened is obvious to all. I wonder whether in looking up the history of the education of women, it has occurred to the Professor what an enormous amount of money, pains, and trouble women have spent upon the education of men. The history of the Oxford and Cambridge Universities is a remarkable proof of this. I have often thought that really in that respect, purely from a monetary point of

view, men do owe a little monetary help to the higher education of women. Referring to the names of the distinguished ladies who were pioneers of education, I may mention that there was in Belfast a lady—Mrs. Elizabeth Hamilton—who in the year 1800 published a book on the education of women, which is worth reading, for its practical hints, to-day. It is true that she lived a great deal in Scotland, nevertheless she was a Belfast woman, and though Belfast was a very small place in those days, not one of us could possibly use stronger language, or claim a higher place for women than she did. I have been thinking also of the immense strides this question has made since I first attended some of the meetings held in this room on the subject of higher education. I may say that the Queen's University was only a few months behind Cambridge in founding local examinations for women. It was in this very room that the first year's examinations were held. Last year as one of the Englishwomen's Committee of Education for the Chicago Exhibition, I had occasion to make a complete collection of reports, &c., connected with the education of girls in Ireland, to send out there; from these I found that we had a more complete state-aided system than exists in either England or Scotland. It is perfectly true that we have nothing like the same amount of money, but a more complete system. The National system provides an elementary education all over the country, and the intermediate system has given an immense lift to the secondary education of boys and girls. It is under state supervision and state sanction, and then the Royal University is as open to women as to men. I think that we ought not here to overlook the immense work which has been done by one lady—Mrs. Byers—in creating by her own brains the Victoria College, from which a very considerable number of graduates of the Royal University have come. It is with the greatest possible pleasure that I second the vote of thanks.

Mr. Milligan.—I think the Irish Celts must be excepted from what the learned Professor has stated. At a very early period women had equal rights with men as to the inheritance of land

in Ireland. It was an Ulster woman who first got this privilege for her sex, and thus secured women's rights as far as the inheritance of land was concerned. This lady was the daughter of the Chief Poet of Ulster. Up to her time women could not inherit land ; if a father died without sons the land went to the nearest male relative. She succeeded in getting this law repealed, and afterwards women had equal rights with men to inheritance of land.

Mr. Martin.—During my own vacation some little time ago, I heard a great deal about the position of the lecturer of this evening, and the interest he has taken in regard to the education of women. I heard that his lecture on that subject had accomplished a great deal of good in Scotland and England, and it occurred to me that I might utilse a little leisure by seeking an interview with our lecturer, which I did, and try to persuade him to come over here and give us the benefit of his experience. He is really the leading authority in regard to this question. The only objection I have to his views is this, I think that the educators of women and the wise men would do a great deal of good to society provided they advanced just a little farther. I should like to see our women getting their place in the Universities as fully as the men, and be at liberty to record their opinions by vote. I do hope that this is only the first of a little series of lectures that we may have in this city from this very emiment educationalist.

Professor FitzGerald.—I don't think I need say anything in addition to putting the vote of thanks proposed by Dr. Redfern and supported by Miss Tod, Mr. Gray, and Mr. Martin. It seems to me that the information given us is of extremely great value, because the study of the history of women's higher education shows that many of those terrible consequences which have often been anticipated have not ensued in past times, and we are therefore justified in concluding that they are not likely to ensue in any future time. One might take many of the Professor's lectures as texts, and, as he says, expand them to a much greater length, but from want of time and information on

my own part I shall refrain from attempting to make any crude remarks on the subject, and will simply convey to Professor Knight our very heartfelt thanks for the lecture given us.

Professor Knight.—I sincerely thank you for the vote. It has been a great pleasure to me to be here. It is a favourite motto of my life that "it is more blessed to give than to receive." I think to-night, in the speeches which have followed, that I have received as much as I have given. I have learned a great many new things of which I was only partly informed. With reference to the remarks that fell from Mr. Martin, I have the utmost sympathy with women having those higher privileges, not merely voting, but teaching in the University. I would hail the day when University professorships would be open to women I do not see anything to prevent that. I should like to see the experts of the female sex, who are more compent to teach some subjects than we are, installed as University lecturers or professors of those subjects. I have only glanced at the fringe of this great question to-night, and I thank you most cordially for the interest you have taken in my remarks. If it is possible for me in the future to again visit this delightful city, it will certainly give me very great pleasure.

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OF THE

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NATURAL HISTORY & PHILOSOPHICAL SOCIETY

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BELFAST:
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Each Shareholder and Member has the right of personal attendance at all meetings of the Society, and of admitting a friend thereto; also of access to the Museum and Library for himself and family, with the privilege of granting admission orders for inspecting the collections for any friend not residing in Belfast.

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Belfast Natural History and Philosophical Society.

ANNUAL REPORT, 1894.

The Annual Meeting of the Shareholders was held in the Museum, College Square North, on 25th July, "to receive the Council's report for the past twelve months, along with the Treasurer's Statement of Accounts; to elect five members to the Council of Management for 1895-96, in the place of five who retire and are eligible for re-election; and to transact such other business as may be brought forward pertaining to an annual meeting." Mr. R. Lloyd Patterson, J.P., F.L.S., presided, and the attendance included Messrs. W. H. Patterson, Isaac Ward, Robert M. Young, B.A., Secretary; George Kidd, J.P.; J. H. Greenhill, James O'Neill, M.A.; R. A. Kyle, E. Forbes Patterson, T. F. Shillington, and Drs. John MacCormac and Calwell.

The Hon. Secretary (Mr. R. M. Young) read the notice convening the meeting, and submitted the annual report as follows:—"The Council of the Belfast Natural History and Philosophical Society desire to submit their report of the working of the Society during the past year. The winter session was opened in the Museum, College Square, on 13th November, 1894, when the President of the Society (Mr. Robert Lloyd Patterson, F.L.S.) delivered an inaugural address. The second meeting was held on 27th November, 1894, when a lecture was kindly delivered by Rev. W. S. Greene, M.A., Her Majesty's inspector of fisheries—subject, 'Sea Fish and Fishing off the West of Ireland,' illustrated by a specially prepared series of lantern slides. The third meeting was held on 4th

December, 1894, when the following papers were read :—1, by Mr. John Brown, 'Electrolytic Crystallisation of Metals ;' 2, by Mr. A. S. Cleaver, B.A., 'Through the Hot Lake District of New Zealand.' At the fourth meeting, held on 8th January, 1895, on the proposal of the President, a vote of condolence was passed to the relatives of the late Mr. Robert S. MacAdam, and the Hon. Secretary (Mr. R. M. Young, B.A.) gave a brief description of two Irish sepulchral urns recently presented to the Museum. An illustrated lecture entitled 'Old Belfast,' prepared by Mr. John J. Marshall, was then read by Mr. W. Gray, M.R.I.A., the photo slides being shown by Messrs. Marshall and Allen. The fifth meeting was held on 5th February, 1895, when two papers were read—1, by Dr. John MacCormac, on 'Education and Innervation,' illustrated by a special series of lantern photo slides ; 2, by Mr. Seaton F. Milligan, M.R.I.A., Vice-President R.S.A.I., on 'Antiquarian Collections in Ulster.' The sixth meeting was held on 5th March, 1895, when a lecture was kindly delivered by Mr. W. Redfern Kelly, M.I.C.E., F.R.A.S.—subject, 'The Great Mystery of Stellar and Planetary Evolution.' The seventh meeting was held on 2nd April, 1895, when a lecture was given by Mr. James Wilson, M.E.—subject, 'The Alps, with Rope and Axe,' illustrated by a fine series of lantern views, taken by the lecturer. All the above meetings were largely attended, some of them inconveniently so, by members of the Society and their friends. In the last annual report reference was made to the fact that your Council had been able to secure a course of Gilchrist lectures for the city, and the hope was expressed 'that this action would be fully justified by the success of the series in Belfast and other Ulster towns.' This expectation has been more than realised by the unqualified success of these lectures, which were delivered at intervals of a fortnight during the last four months of 1894, by Professor Lewes, Sir R. S. Ball, Rev. W. H. Dallinger, Dr. Roberts, Professor Laurie, and Dr. A. Wilson. Sir Robert Ball's lecture in the Ulster Hall, at which the chair was taken by your President, was listened to by an

overflowing audience. Your Council considered that it would be unwise, in view of the Gilchrist lectures, to hold the usual series of popular scientific lectures, but trust that they may be resumed next session.

It will be observed from the balance sheet of the Society, which has been drawn up by the Hon. Treasurer in accordance with the requirements of the Local Government Board and duly audited by the official auditor, that the financial condition of the Society and Museum continues fairly satisfactory. The additional rooms acquired by the Belfast Naturalists' Field Club have been fitted up, and are now in their occupation. The large lecture hall was rented for a series of lectures by the Belfast Society for Extension of University Teaching, and, as in former years, the rooms in the Museum have been used for the holding of a number of meetings of local scientific societies. Since the last annual meeting your Society has to deplore the loss of one of their oldest and most valued members, the late Robert S. MacAdam, best known as the former editor of the *Ulster Journal of Archæology*. As already mentioned, a vote of condolence was passed to his relatives at the first meeting after his decease, and was duly and appreciatively acknowledged by them. The Museum was opened on Easter Monday and Tuesday at the usual nominal charge, and large numbers of the public availed themselves of the privilege, though, owing to counter attractions, particularly the Exhibition, the visitors to the Museum were scarcely up to the average. The Curator continues to discharge his duties to the full satisfaction of your Council, and, his former assistant having resigned, John Sinclair has been appointed as his successor. A list of donations to the Museum, and of publications received in exchange from home and foreign societies, will be printed with the present report. Among the recent additions to the Museum are two oil portraits which are specially noteworthy. They were presented to the Society at the first meeting of the winter session, and were described in the President's inaugural address. One is a half-length portrait of the late William Thompson, for many years

President of the Society, author of the 'Natural History of Ireland.' This valuable work of art was bequeathed by his sister, the late Miss Jane Thompson. The other is an excellent likeness of the late Robert Patterson, F.R.S., author of 'Zoology for Schools' and several other works, one of the founders of the Society, and for various and lengthened periods its president. This was presented by his son, our present President. To these have since been added a portrait in oil of the late Robert S. MacAdam, presented by his cousin, Miss Anna MacAdam, together with a selection of his books. Amongst the miscellaneous objects recently acquired may be mentioned the perfectly preserved head of a soldier killed in 1798. It was found in a peat bog near Dungannon. The Council desire, on behalf of the Society, to thank the local press for their admirable reports of our public meetings. This meeting will be asked to elect five members of Council in place of the gentlemen who retire in accordance with the new constitution, and who are eligible for re-election."

Mr. BROWN (Treasurer) submitted the annual financial statement, which showed that there is a balance on hands of £11.

The CHAIRMAN, in moving the adoption of the report, referred to its leading features, and said he knew there were some gentlemen there that day at some inconvenience. He would therefore not detain them more than was absolutely necessary. The meeting was held later than usual owing to circumstances more or less unavoidable. It would be their endeavour to hold their annual meeting nearer to the working session. He did not recollect any occasion on which they met so late as the last week in July. He begged to move the adoption of the report.

Mr. SHILLINGTON, in seconding the motion, referred to the satisfactory nature of the report. He thought the Society was to be congratulated on two or three things, especially on the bringing of the Gilchrist lecturers to Belfast during the year, and he hoped now, that that movement had been inaugurated, they would be the means of bringing popular lecturers to Belfast. He did not think they had any reason to be disheartened at the

results of Easter Monday's visits. The Exhibition was just opened at that time.

The report was adopted.

Mr. YOUNG read the following as the list of donations to the Museum in 1894-95 :—From Robert Patterson, Esq., Malone Park, specimens of a large balanus (*Diademia coronula*); Robert MacAdam, Esq., a number of fossils and shells; Directors of the Belfast Commercial Buildings, ancient leaden trunk-head of a spout from a house in Bridge Street, taken down in 1894; Miss S. M. Thompson, Macedon, Whitehouse, rock specimens from County Donegal; James Thompson, Esq., J.P., Macedon, Whitehouse, a portfolio of lithograph portraits, by Hanhart, of the leading scientists assembled at Ipswich meeting of the British Association in 1851; W. H. M'Laughlin, Esq., Brookfield House, Belfast, specimens of fossil coral (*Lithostrotian basaltiforme*) from Armagh; Edward M'Connell, Esq., a specimen of syenite from Rostrevor; Robert Corry, Esq., Sandown, The Knock, a sepulchral urn dug up at Knock in 1894; the Misses Crawford, College Green, Belfast, a lady's richly embroidered spencer of the period of Queen Anne, made at Carrickfergus; the late Miss Jane Thompson, Dublin, per James Thompson, Esq., J.P., Macedon, Whitehouse, a large portrait in oil of her brother, the late William Thompson, author of the "Natural History of Ireland"; Robert Lloyd Patterson, Esq., F.L.S., J.P., portrait in oil of the late Robert Patterson, F.R.S., author of "Zoology for Schools," and one of the founders of the Society; W. Swanston, Esq., F.G.S., a bust of Professor Edward Forbes, F.R.S.; Miss MacAdam, portrait in oil of the late Robert M'Adam, formerly editor of the *Ulster Journal of Archæology*; the Corporation of the City of London, two medals struck in commemoration of the marriage of the Duke of York and the visit of the King of Denmark; Mrs. Hewitt, specimen of a large butterfly *(Papilio luna)* from Michigan; Miss Hyndman, Ardenlee, Belfast, a box of small medallions.

Dr. MACCORMAC moved a vote of thanks to the donors to the Museum, and also to their estimable Honorary Secretary, Mr.

Young. Why did he ask their liberty to do that? It was because he was fully aware of the valuable services rendered by Mr. Young, and of Mr. Young's indefatigability, kindness, and gentlemanly conduct at all times. He had much satisfaction in proposing that the best thanks of that meeting be given to Mr. Young.

Mr. GREENHILL seconded the motion, which was passed.

Mr. GEORGE KIDD, J.P., then moved a vote of thanks to the chairman, referring to the indebtedness of the organisation to Mr. Patterson's father and to himself.

Mr. O'NEILL seconded the motion, which was carried by acclamation.

The PRESIDENT said it was a source of pleasure to continue to be closely identified with the institution of which his father was one of the parents, and of which he was so proud.

The Committee was re-elected, and the following were chosen office-bearers for the ensuing year :—President, R. Lloyd Patterson, J.P. ; Vice Presidents, John Brown, W. Swanston, Dr. J. A. Lindsay, and Professsor FitzGerald ; Hon. Treasurer, John Brown ; Librarian, T. Workman ; Hon. Secretary, R. M. Young.

The meeting then terminated.

EDUCATIONAL ENDOWMENTS (IRELAND) ACT, 1885, 48 & 49 Vict., ch. 78.

The Account of the Council of the Belfast Natural History and Philosophical Society for the year ended 30th April, 1895.

Dr. **Cr.**

CHARGE.

				£	s.	d.
To Balance as per last Account				£10	2	2
,, Amount of Subscriptions received in the year ended 30th April, 1895				134	1	0
,, Amount of Dividends received in the year ended 30th April, 1895				17	8	5
,, Amount of Rents received in the year ended 30th April, 1895				43	5	6
,, Amount of Fees received in the year ended 30th April, 1895				0	4	0
,, Amount of Miscellaneous Receipts in the year ended 30th April, 1895 (not included in the foregoing), viz.:—						
Entrance fees at door on Easter Monday	£22	1	8			
Do. do. Tuesday	4	11	2			
Do. do. from May 1, '94, to date	18	15	3			
				45	8	1
Total				£250	9	2

DISCHARGE.

				£	s.	d.
By Amount of Payments made in the year ended 30th April, 1895, under the following headings—						
Maintenance of Premises, &c. ...	£26	17	1			
Rent and Taxes, &c.	27	11	0			
Salaries	90	9	3			
				£144	17	4
Other Payments, viz.:—						
Printing and Stationery	13	1	7			
Advertising	13	3	4			
Postage and Carriage	8	19	1			
Fuel and Gas	17	1	4			
Subscriptions to Museum's Association	1	1	0			
Insurance...	10	11	6			
Auditor's Fee	1	1	0			
Cheque Book	0	4	2			
Printing Report	18	11	4			
Subscription to Ulster Journal of Archaeology	0	5	0			
Rev. W. S. Green's Travelling Expenses	1	14	4			
Expenses at Easter	8	10	1			
				94	3	9
Total Payment				£239	1	1
,, Balance in favour of this Account on the 30th April, 1895				11	8	1
Total				£250	9	2

N.B.—Besides the above Balance there is a sum of £400 standing to the credit of this Account in the York Street Spinning Co., Ltd., 4½ per cent. Debenture Stock.

We certify that the above is a true Account.

R. LLOYD PATTERSON, Governor.
J. BROWN, Accounting Officer.

Dated this 21st day of May, 1895.

I certify that the foregoing Account is correct.

J. F. MAYNE, Auditor.
18th day of June, 1895.

DONATIONS TO THE MUSEUM, 1894-95

From W. Swanston, Esq., F.G.S.

A bust of the late Professor Edward Forbes, F.R.S.

From James Thompson, Esq., J.P.

Portfolio of lithograph portraits, by Hanhart, of the leading scientists assembled at the Ipswich meeting of the British Association in 1851.

From Robert Patterson, Esq.

Specimen of a large balanus (*Coronula diadema*).

From Robert MacAdam, Esq.

A number of fossils and shells.

From The Directors of the Belfast Commercial Buildings.

Ancient leaden trunk-head from the front of a house in Bridge Street, taken down in 1894.

From Miss Sydney M. Thompson, Macedon.

Rock specimens from County Donegal.

From W. A. M'Laughlin, Esq.

Specimens of fossil coral (*Lithostrotian basaltiforme*) from Armagh.

From The late Miss Jane Thompson, Dublin.

Large portrait, in oil, of the late William Thompson, author of the Natural History of Ireland.

From R. Lloyd Patterson, Esq., J.P., F.L.S.

Portrait, in oil, of the late Robert Patterson, F.R.S., author of several Zoological works, and one of the founders of the Society.

From Miss Anna MacAdam,

Portrait, in oil, of Robert MacAdam, former editor of the Ulster Journal of Archæology.

From Edward M'Connell, Esq.

Specimen of syenite from Rostrevor.

From The Corporation of the City of London.

Two medals struck in commemoration of the marriage of the Duke of York, and the visit of the King of Denmark.

From Robert Corry, Esq.

The sepulchral urn dug up at Knock.

From The Misses Crawford, College Green.

A ladies' richly embroidered spencer, made near Carrickfergus in the times of Queen Anne.

From Mrs. Hugh Hyndman.

A box of classic medallions.

ADDITIONS TO THE LIBRARY, 1st MAY, 1894, till 1st MAY, 1895.

Adelaide.—Transactions of the Royal Society of South Australia. Vol. 18, 1893-94. *The Society.*

Albany.—The 45th and 46th Annual Reports of the New York State Museum, 1892 and 1893. *The Director.*

Austin, Texas.—The Principles of Elliptic and Hyperbolic Analysis, by Professor A. Macfarlane, LL.D. *The Author.*

Belfast.—Report and Proceedings of the Belfast Naturalists' Field Club. Ser. 2, vol. 4, part 1. *The Club.*

Catalogue of Early Belfast Printed Books, by John Anderson, J.P., F.G.S. *The Editor.*

Berlin.—Verhandlungen der Gesellschaft für Erdkunde zu Berlin. Vol. 21, nos. 4-9, 1894; and vol. 22, nos. 1—3, 1895. *The Society.*

Boston.—Proceedings of the Boston Society of Natural History. Vol. 26, parts 2 and 3, 1894. Memoirs, vol. 3, no. 14, 1894; and Occasional Papers, no. 4, also Geology of the Boston Basin, vol. 1, part 2; and maps. *The Society.*

Breslau.—Zeitschrift für Entomologie herausgegeben vom Verein für Schlessiche Insektenkunde zu Breslau. New series, part 19, 1894. *The Society.*

Brighton.—Report and Abstracts of the Brighton and Sussex Natural History and Philosophical Society, 1894. *The Society.*

BRUSSELS.—Bulletin de la Société Royale Botanique de Belgique. Vols. 30—32, 1891-94. *The Society.*

Annales de la Société Entomologique de Belgique. Vols. 27 and 28, 1893-94. *The Society.*

CALCUTTA.—Records of the Geological Survey of India. Vol. 27, parts 1—4, 1894; and vol. 28, part 1, 1895; also Geology of India, Stratigraphical and Structural (Oldham), 1893.
The Director of the Survey.

CAMBRIDGE.—Proceedings of the Cambridge Philosophical Society. Vol. 8, part 4, 1895. *The Soeiety.*

CAMBRIDGE, U.S.A.—Bulletin of the Museum of Comparative Zoology. Vol. 25, nos. 7—11, 1894; and Annual Report of the Curator, 1894.
Alex. Agassiz, Curator.

CARDIFF.—Report and Transactions of Cardiff Naturalists' Society. Vol. 26, part 1, 1894. *The Society.*

CASSEL.—Bericht (39) des Vereins für Naturkunde zu Kassel, 1894. *The Society.*

CORDOVA.—Boletin de la Academia Nacional de Ciencias in Cordoba. Vol. 12, part 1. *The Academy.*

CHRISTIANIA.—Forhandlinger i Videnskabs Selskabet i Christiania. Nos. 1—21, 1893, and Oversigt, 1893.
The Royal University of Christiania.

DANTZIC.—Schriften der Naturforschenden Gesellschaft in Danzig. Vol. 8, parts 3 and 4, 1894.
The Society.

DUBLIN.—Scientific Transactions of the Royal Dublin Society. Ser. 2, vol. 4, part 14, 1892; and vol. 5, parts 1—4, 1893

Proceedings, vol. 7, part 5, 1892; and vol. 8, parts 1 and 2, 1893. *The Society.*

EDINBURGH.—Transactions and Proceedings of the Botanical Society of Edinburgh. Vol. 20, part 1, 1894. *The Society.*

Proceedings of the Royal Physical Society. Vol. 12, parts 1 and 2, 1893-94. *The Society.*

EMDEN.—Jahresbericht (78) der Naturforschenden Gesellschaft in Emden, 1892-93. *The Society.*

GENOA.—Giornale della Società di Letture e Conversazioni Scientifiche di Genova. Anno 17, January and March, 1895. *The Society.*

GLASGOW.—Proceedings of the Philosophical Society of Glasgow. Vol. 25, 1894. *The Society.*

HALIFAX, N.S.—Proceedings and Transactions of the Nova Scotian Institute of Science. Ser. 2, vol. 1, part 3, 1893. *The Institute.*

HALLE.—Leopoldina, Amtliches Organ der Kaiserlichen Leopoldino-Carolinischen Deutschen Akademie der Naturforscher. Vol. 29, 1893. *The Academy.*

HAMBURG.—Abhandlungen aus dem Gebiete der Naturwissenschaftlichen Verein in Hambourg. Vol. 13, 1895. Verhandlungen.

IGLO, Austria-Hungary.—Jahrbuch des Ungarischen Karpathen Vereines. *The Society.*

Kharkow.—Travaux de la Section Medicale de la Société des Sciences Experimentales. Vol. for 1893. Also Section des Physico Chimiques, part 1, 1894. *The Society.*

LAUSANNE.—Bulletin de la Société Vaudoise des Sciences Naturelles. Ser 3, vol. 30, nos. 114 and 115, 1894. *The Society.*

LONDON.—Reports of the British Association. Volume for 1893; and volume for 1894.
The Association.

Quarterly Journal of the Geological Society. Vol. 50, parts 198—200; and vol. 51, part 201, 1895; also, List of Fellows for 1894. *The Society.*

Journal of the Royal Microscopical Society. Nos. 100—103, 1894; and nos. 104 and 105, 1895.
The Society.

Transactions of the Zoological Society. Vol. 13, part 9, 1894. Proceedings, parts 2 and 3, 1894.

MADRAS.—Bulletins 1—3 of the Madras Government Museum, 1894-95; and Administration Report for the year, 1893-94.

MANCHESTER.—Journal of the Manchester Geographical Society. vol. 9, nos. 7—12, 1893; and vol. 10, nos. 1—3, 1894. *The Society.*

Transactions of the Manchester Geological Society, Vol. 22, parts 16, 18, 19, 20, 21, 1894; and vol. 23, parts 1—4, 1894-5. *The Society.*

MEXICO.—Anuario del Observatorio Astronomico Nacional de Tacubaya. Ano 15, 1894, and Boletin, vol. 1, nos. 17—20, 1894-95. *The Director.*

MILWAUKEE.—Eleventh and Twelfth Annual Reports of Milwaukee Public Museum, 1893-94.
The Trustees.

MINNEAPOLIS.—Bulletin 9, part 3, of the Geological and Natural History Survey of Minnesota, 1894.

First Report of the State Zoologist, with Notes on the Birds of Minnesota, 1892, from H. F. Nachtrieb, State Zoologist.

MOSCOW.—Bulletin de la Société Impériale des Naturalistes de Moscou. Nos. 1—4, 1894; and no. 4, 1895.
The Society.

NANTES.—Bulletin de la Société des Sciences Naturelles de L'ouest de la France, vol. 4, parts 1—3, 1894.
The Society.

NEW YORK.—Annals of the New York Academy of Sciences. Vol. 7, nos. 6—12, and vol. 8, no. 4, 1894.
The Academy.

Bulletin of the American Geographical Society. Vol. 25, no. 4, part 2, 1893; and vol. 26, nos. 1—4, 1894. *The Society.*

ODESSA.—Memoirs of the Society of Naturalists of New Russia Vol. 18, part 2, 1894. *The Society.*

OPORTO.—Annals de Sciencias Naturaes. Vol. 1, 1894; and vol. 2, nos. 1 and 2, 1895.
The Director of the Biological Laboratory.

PADUA.—Bulletino della Società Veneto-Trentina di Scienze Naturali in Padova. Vol. 5, no. 4, 1894; and Atti, ser. 2, vol. 2, fasc. 1. 1895. *The Society.*

PHILADELPHIA.—Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 23, nos. 144 and 145, 1894; and vol. 31, no. 142, 1893.
The Academy.

Proceedings of the American Philosophical Society. Vol. 31, no. 142, 1893; and vol. 33, nos. 144 and 145, 1894. *The Society.*

PISA.—Atti della Società Toscana di Scienze Naturali, Processa Verbali. Vol. 9, 4 parts, March till November, 1894. *The Society.*

RIO DE JANEIRO.—Archivos do Museu Nacional. Vol. 8, 1892.
The Director.

ROME.—Atti della Reale Accademia dei Lincei. Vol. 3, 1st semestre, fasc. 8—12, 1894; 2nd semestre, fasc. 1—12, 1894; vol. 4, 1st semestre, fasc. 1, 2, 3, 5, 6, 7; 2nd semestre, fasc. 4, 1895; also Rendiconto dell 'Aduanza Solenne dell 3 June, 1894. *The Academy.*

Bollettino della Società Romana per gli Studi Zoologici. Vol. 3, nos. 2—6, 1894 ; and nos. 1 and 2, 1895. *The Society.*

STAVANGER.—Stavanger Museums Aarsberetning for 1893. *The Trustees.*

STIRLING.—Transactions of the Stirling Natural History and Archæological Society for 1893-94. *The Society.*

STOCKHOLM.—Handlingar of the Royal Swedish Academy. Vol. 25, parts 1 and 2, 1892 ; Bihang, parts 1—4, 1893 ; Ofversigt, vol. 50, 1893 ; and Lefnadsteckningar, vol. 3, part 2, 1894 ; also Carl Von Linne's Brefvexling, 1885. *The Academy.*

TOKIO.—Mittheilungen der Deutschen Gesellschaft für Natur- und Volkerunde Ostasiens. Vol. 6, 2 parts, 1894. *The Society.*

TORONTO.—Transactions of the Canadian Institute. Vol. 4, part 1, no. 7, 1894 ; and Report of the Minister of Education, 1894. *The Institute.*

UPSALA.—Bulletin of the Geological Institution of Upsala. Vol. 1, no. 1, 1892, and no. 2, 1893. *The Institution.*

VENICE.—La Notarisia Commentario Ficologico. Vol. 9, parts 4 and 5, 1894. *The Editor.*

VICENZA.—Laghi Alpini Valtellinesi, by Professor Paulo Pero, 1894. *The Author.*

VIENNA.—Verhandlungen der Kaiserlich-Koniglichen Geologischen Reichsanstalt. Nos. 1—3, and nos. 5—18, 1894. *The Society.*

Verhandlungen der Kaiserlich-Koniglichen Zoologisch-Botanischen Gesellschaft. Vol. 44, parts 1—4, 1894 ; and vol. 45, parts 1—3, 1895. *The Society.*

WASHINGTON.—Annual Reports of the American Historical Association for the years 1892 and 1893.
The Association.

Tenth Annual Report of the Bureau of Ethnology, issued for year 1888-89, 1893; also Bibliography of the Wakashan Languages, the Pamunkey Indians, and the Maya Year, 1894.
The Bureau of Ethnology.

Annual Report of the United States Geological Survey. Vol. 12, parts 1 and 2, 1890-91; vol. 13, parts 1 and 2, 1891-92. Bulletins, nos. 97—117, 1893-94. Monographs, vol. 19, 1892, and vols. 21 and 22, 1893. Mineral Resources, vols. for 1892 and 1893. *The Director.*

Proceedings of the United States National Museum. Vol. 15, 1892; and vol. 16, 1893; and Bulletins nos. 43—46, 1893. *The Director.*

Smithsonian Report, 1892; and Smithsonian Reports of United States National Museum for 1891 and 1892. Smithsonian Contributions to Knowledge, vol. 27, no. 884, "The Internal Work of the Wind," *The Institution.*

ZURICH.—Vierteljahrschrift der Naturforschenden Gesellschaft in Zurich. 39th year, parts 2—4, 1894; and 40th year, part 1, 1895; also Neujahrsblatt for 1895. *The Society.*

From R. LLOYD PATTERSON, Esq., J.P., F.L.S.—Journal of the Linnean Society—Botany, vol. 26, no. 177, 1894; vol. 30, nos. 208 & 209, 1894; and 210, 1895. Zoology, vol. 24. no. 157, 1894; vol. 25, nos. 158—60, 1894; also Proceedings, May, 1894.

From MISS ANNA MACADAM, Belfast.—A large number of books and manuscripts, being a selection from the library of the late Robert MacAdam, Esq.

BELFAST

NATURAL HISTORY & PHILOSOPHICAL SOCIETY

SESSION 1894-95.

13th November, 1894.

INAUGURAL ADDRESS BY THE PRESIDENT.

Robert Lloyd Patterson, Esq., J.P., F.L.S.

The President, who was cordially received, said that, on assuming the presidential chair at that the opening meeting of the seventy-fourth session of their Society he was pleased at being able to congratulate his fellow-members on its continued vitality and activity, notwithstanding its advancing years. His warm thanks were due to the Council for having for the third time, after an interval of thirteen years since his first election as president, again placed him in that position. It was one the honour of which he fully appreciated, and the responsibilities of which he trusted he was sensible of, and the duties of which it should be his earnest endeavour adequately to discharge. Continuing, the President said that, to the thoughtfulness of a lady—a life-long friend and well-wisher of the Society, the late Miss Thompson—they were indebted for the bequest of an admirable portrait of her brother, Mr. William Thompson, one of the most distinguished of their former presidents. A member had presented a very good likeness of another former president, Mr. Robert Patterson, while to a valued and useful member, Mr. Swanston, they were much indebted for the recent gift of a bust of one of the most eminent naturalists the century had produced — Professor Edward Forbes—a man of truly remark-

able powers and brilliant genius. The three had been united in bonds of the closest friendship, cemented by a community of taste and of interest in certain branches of science, the pursuit of which was to Forbes a profession, to Thompson—a man of means and leisure—an occupation ; but to Patterson—a man of business—merely a relaxation. It occurred to him (the President) that the acquisition by the Society almost simultaneously of these mementoes of the three friends might fittingly be made the occasion of a brief review of their lives. He could not recall Mr. Forbes. He knew he had seen him ; but he remembered Mr. Thompson very well indeed. He was the first of the three to be called away. After speaking of the early life of Mr. Thompson, the President pointed out that his first contribution to the proceedings of one of the English learned societies seemed to have been in 1833—a communication on the Arctic Tisu and other rare birds observed in Ireland made to the Zoological Society of London. From that period up to the time of his premature and lamented death he was a frequent and valued contributor to the different English scientific journals. Visits to London, and later the annual meetings of the British Association for the Advancement of Science, brought him into contact with the most eminent men of the day, who were not slow in discovering what a power of observation, research, and description lay in the modest, retiring young Irishman, who soon took his place as their peer simply by the intuitive right of genius among the foremost of them. Without reference to Queen's College, which did not then exist, but to which they since owed much, the Belfast of forty-five or fifty years ago took a higher relative plane as regarded both literature and science than did the much larger and wealthier city of to-day. Besides Mr. Thompson, he remembered Dr. Hincks, Dr. Drummond, Mr. Grattan, Mr. Hyndman, Mr. Richard Davidson, Sir James Emerson Tennant, Rev. John Scott Porter, Mr. James Bryce, Mr. Garrett, Mr. Bottomley, Dr. MacCormac, Mr. Gordon Thompson, Mr. Edward Getty, Dr. Staveley, Mr. James MacAdam, Dr. Andrews, and others only lately removed from

them, not to mention some who happily still remained. The public lives of these became so interwoven with one another and with those of their fellow-workers in the same branches elsewhere that it might be well to mention the names of some of the latter, foremost among whom as friends stood Edward Forbes and Robert Ball, the latter the respected sire of a distinguished son, who lately honoured Belfast with a visit. The names of the others were legion, but amongst these he vividly recalled Captain Graves, R.N.; Professor Balfour, Dr. Lyon Playfair (now Lord Playfair), Professor Jukes, Dr Allman, the Earl of Enniskillen, Dr. Carpenter, Prince Charles Lucien Bonaparte, Sir Roderick Murchison, Professor Owen, and Hugh Miller, not to mention many others equally distinguished, of whom, however, he had no personal recollection. Sir C. Wyville Thomson and others appeared later.

The President then dealt with the late Mr. Thompson's love for art as well as for nature, and said he became president of that Society in 1843, and continued to take a deep interest in its affairs. An important contribution to ornithology was made by Mr. Thompson in 1849 in a work on the natural history of Ireland. It at once took the leading position its exhaustive character and scientific accuracy no less than its literary merit entitled it to, and confirmed its gifted author in the position he had already won as the leading Irish authority on the subject. The President said Mr. Thompson died suddenly when only forty-six years and three months old, and, while he had no recollection of the profound sensation caused in Belfast by his early and sudden demise, he could well imagine it. As a proof of his untiring industry, Mr. Patterson mentioned that the number of Mr. Thompson's published papers, including his "Natural History of Ireland," &c., was seventy-three. As to Robert Patterson, he should for obvious reasons say less. He survived his friend Thompson exactly twenty years. His was an uneventful, busy, happy life, passed in a business to which he had been brought up, which he inherited from his father and left to his eldest son. With him literature and science,

although a passion, were merely a relaxation, not an occupation. His books were written in the leisure of his evenings at home, and published with the hope of enlisting more general interest in the study of natural history. He was one of the earliest, strongest, and most consistent advocates for the adoption of natural history as a regular part of the education of our youth, and he lived to see the realisation of much of his dream. Mr. Patterson was one of the seven founders of the Society in 1821. He passed through almost every minor office in it till 1852, when on Mr. Thompson's death he was elected president, an office which he subsequently filled on more than one occasion. Referring to Professor Forbes, the speaker said he was an original commanding genius, and a most interesting personality. He was born at Douglas, Isle of Man, on the 12th February, 1815, and died at Edinburgh on the 18th November, 1854, aged only thirty-nine years and nine months. During his short life he accomplished an enormous amount of work. Mr. Patterson then gave some very interesting particulars of Forbes's life, taken from his biography. His first visit to Ireland seemed to have been in 1840, and at Belfast, his biography states, he found his old friends and fellow-naturalists, William Thompson and Robert Patterson. In 1844 Forbes received the appointment of palæontologist to the Geological Survey, and he now entered into a position congenial to his tastes, which gave him more leisure than the offices he had previously filled. He married in 1848 a daughter of General Sir C. Ashworth, whom he met when visiting a friend's house. His married life was very happy, but all too short. In 1851 the School of Mines, which might be regarded as an outcome of the Geological Survey, was established, and in it Forbes got the appointment of lecturer on natural history as applied to geology and the arts. The height of Forbes's ambition was reached in 1854, when he was appointed, on the death of his old master, Professor Jameson, to the chair of natural history in the University of Edinburgh. His Edinburgh duties commenced under the most favourable auspices and amid great enthusiasm on the 15th May, and

terminated six months thereafter with his death. Thus early closed the life of Edward Forbes, of whom it was no exaggeration to say that his was a most original, versatile, and brilliant intellect of the highest order. His early death was an irreparable loss to the whole scientific world of the period.

The PRESIDENT of the Belfast Queen's College (Rev. Dr. Hamilton) said that the duty which he had been asked to discharge that night was one that was exceedingly congenial to him. His only regret was that it had not fallen into hands more able to do it justice. Before proceeding to formally move the vote of thanks with which he had been entrusted, he could not deny himself the pleasure of expressing his thanks to the learned President of that Society for the address with which he had just favoured them. He learned that it was not the custom to move formally a vote of thanks for such an address ; but speaking for himself—and he was perfectly sure that he was also speaking for them— he must say that he had seldom listened to a more interesting or complete paper of the kind than that which his friend Mr. Patterson had just read to them. That account of the trinity of worthies whose lives he had brought before them was intensely gratifying. He had only one regret about it, and it was that it did not deal at a greater length with the biography of the second of the two gentlemen to whom he had alluded—viz., Mr. Robert Patterson—but he supposed they all understood the reason why he had passed over that part of the subject so briefly. He hoped, however, that at some other meeting, or in some other way, a fuller account of Mr. Patterson's life might be given, because if there was one to whom that Society and the Museum owed a debt of gratitude it certainly was to the father of the learned President of the Belfast Natural History and Philosophical Society. His duty, however, was to move that the best thanks of that Society be given to the donors of the gifts, a list of which had been read to them by Mr. Young. It was very satisfactory to find that the Museum still maintained its popularity, and that so large a portion of the people of Belfast were so thoughtful as to remember it when they had

objects of interest worthy to find a place on its shelves. He supposed that he might say with truth that the two most notable objects in that collection were the two portraits before them. It seemed to him a peculiarly fitting thing that those two portraits should come to the Society together, and were that night at once placed side by side upon the walls of that room. Both Mr. Thompson and Mr. Patterson were Belfast men bred and born as they said, and they not only lived in Belfast all their lives, but they loved Belfast. Indeed, there was a curious parallelism between their careers throughout. Not only were they both Belfast men, but they both devoted themselves to the study of natural history, both gave themselves to the service of that Society, and both were elevated in their turn to the highest office in the Society, the office of president. When Mr. Thompson died Mr. Patterson became his literary executor, and carried through the Press the fourth volume of his "Natural History of Ireland," prefixing to it a biography of his friend. And now it was a surely interesting thing that when the one had been lying in his grave more than forty years, and the other in his more than twenty, they were still united in death as they had been in life. Their portraits on the one night coming into the possession of the Society would hang together on those walls to tell future generations of the manner of men they both were, and continue to stimulate Belfastmen to the study of that branch of science to which both of them so heartily devoted themselves. Mr. Thompson he never had the pleasure of knowing; Mr. Patterson he could remember well, and if in any place his name ought to be mentioned with honour in Belfast it should be there. It had always struck him as a remarkable thing that that young man of only nineteen years of age should have been one of the founders of that Society. It proved to them how early the love of science had been born within him, and how strongly it grew with his life and strengthened with his strength. As they had heard already, that occurred in the year 1821, and from that time until his death, 1872, everyone knew that that Society and that Museum were dear to him. Many of them had heard, and

some of them would recollect that, in the year 1871 the completion of his fifty years' connection with the Society was commemorated with an address—a copy of which he (Dr. Hamilton) had in his possession—which was presented to Mr. Patterson, he supposed in that room. In that address, which was signed by the principal people of Belfast, was used this remarkable language about him—"There is no living man who has done more for the popularisation of the study of natural history in Ireland, or for the giving to it its legitimate place in the education of the young." That language was perfectly true. From the publication of Mr. Patterson's first work, the letters regarding the insects mentioned in Shakspere, down through their various divisions to his "Zoology for Schools" and zoological diagrams, he had one object before him—to press upon the people the study of natural history and make that study easy. It therefore ought to be a matter of very great gratification to that Society—and not only to that Society but to the whole of Belfast—that there would now be in that Museum a portrait of Mr. Patterson to preserve his features and memory for generations yet to come. But there was one more extremely pleasant feature in the proceedings of that evening. Unfortunately, as they all knew, eminent men had not always sons who were like minded. There had been exceptions to that rule, but unfortunately they were not numerous. No one, however, could have listened to the paper read there that night without recognising very clearly the fact that in this case Mr. Robert Patterson, senior, had a son who was worthy of his sire. It was extremely pleasant to find that it was so, and to know that the name was still honoured in the present generation—honoured indeed in more than the present generation, for in the third and he believed in the fourth generations the talent was still descending. Many of them no doubt had enjoyed as he (the speaker) had done the pleasant companionship of his "Birds, Fishes, and Cetacea of Belfast Lough." It had been to him a most useful and charming companion in many a seaside ramble.

Mr. Robert Young, J.P., seconded the motion. He could

not help referring to the fact that he had had the great honour and privilege of knowing both Mr. William Thompson and the President's worthy father. The first time that he really came into contact with Mr. Thompson was at the British Association in 1852. Having made a graceful allusion to the late Mr. Robert Patterson, Mr. Young said that he was sure they had all very much enjoyed the President's address.

The PRESIDENT, in putting the motion, expressed his deep obligations to Dr. Hamilton and Mr. Young for the very kind way in which they had spoken about his father, and the far too flattering way in which they had referred to himself.

The motion was passed by acclamation, and the meeting then concluded.

November 27th, 1894.

Robert Lloyd Patterson, Esq., J.P., F.L.S., President, in the Chair.

Rev. W. S. Green, M.A , F.R.G.S., H.M. Inspector of Fisheries, gave a Lecture on

"SEA FISH AND FISHING OFF THE WEST OF IRELAND."

The President expressed the pleasure it afforded him to preside at a meeting at which their good friend Mr. Green, who had travelled from Dublin to meet them, would lecture. Mr. Green had appeared before Belfast audiences on more occasions than one, and he needed no introduction from him.

Mr. Green then proceeded with his lecture, which he prefaced by throwing on the screen a map of the British Isles, showing the depths of the sea from near the coast down to the profound abysses of the Atlantic. Fishing grounds were only found at moderate depth, these extending to a distance of from ten to twenty miles off the West of Ireland ; but in the North Sea immense fishing areas existed, each having a depth of about fifty fathoms; indeed, these were amongst the finest fishing grounds in the world. While Mr. Balfour was Chief Secretary for Ireland he made an effort with the Royal Dublin Society to start an expedition with the view of developing the Irish fisheries. They had worked for two years from the south of Cork to the north of Donegal and had done some good work. He then proceeded to describe the fishing boats used on the west coast, mentioning that the efforts made in 1847, the year

of the famine, by the British Fisheries Society, which was then started, but which had long since ceased to exist, had borne good fruit. Great improvements had been effected in the boats, and those used on the Donegal coast and other places were made after a model which originally came from Norway. They were weatherly and suitable for certain places, for of course the boat must be such as would suit the peculiarities of different places. The splendid qualities of the fishing canoe used on the west coast were then descanted upon, and by their means, Mr. Green pointed out, a lucrative trade was carried on. As many as ninety French boats and two hundred Manx boats came over to Irish waters every year for mackerel fishing. In addition to spring mackerel fishing there was an autumn mackerel fishing carried on by the natives, and the extent of it could be estimated from the fact that last year as much as £50,000 worth of mackerel had been sent to America, and that exportation had been going on for the past seven years. At several places stations had been established for the curing of fish, these numbering eighteen, and they had been successful on the west coast of Kerry. It had also been tried at Killybegs, and was only on its trial at Mayo, and probably next year something further would be done in this important matter. In this connection Mr. Green mentioned that Mr. Musgrave had greatly facilitated them at Donegal. The next branch of the subject, which was of a highly interesting character, dealt with the development of several species of fish. The eggs, he pointed out, floated in the sea near the surface, the swing of the sea being sufficient to keep them from coming to the surface, where they would be made the prey of various kinds of little enemies. There was an exception to this in the case of the herring, which laid its eggs in the bottom. There were several photos, taken by Mr. Green himself, of a number of the native fishermen of the Arran Islands engaged in working at their perilous calling, and some of the objects of great antiquarian interest which these islands contain were briefly described.

Mr. W. Nicholl acted as lanternist with his usual ability.

The PRESIDENT then called upon

Mr. SEATON F. MILLIGAN, who said he had an announcement to make which he was sure would be received with much interest by all present They proposed at the end of June next, or the beginning of July, to charter a cross-Channel steamer which would start from Belfast and proceed to Rathlin and on to those islands in Galway of which Mr. Green had been speaking, and which possessed some most interesting antiquities, which all who availed themselves of the excursion would have an opportunity of examining.

This announcement was received with applause.

Professor FITZGERALD then proposed a hearty vote of thanks to Mr. Green for his interesting lecture. The subject of Irish fisheries was one that many people there knew little about, except in a general way, and it was an industry that had not been worked up as effectively as it might have been. The Government were fortunate in securing Mr. Green's services as a fishery inspector, and the work which he had done on behalf of the fishing industry in Ireland was of an extremely valuable character, and would have very valuable results.

Mr. JOHN BROWN, in cordially seconding the vote, wished to know Mr. Green's opinion on the question of trawling. He should imagine that trawling could not do the eggs much harm in deep water, and that it was really in shallow water that any injury could be done by trawlers.

The motion was passed by acclamation.

The PRESIDENT conveyed the vote in appropriate terms, and said in reference to the question of trawling he shared Mr. Brown's opinion on the subject.

Mr. GREEN, in acknowledgment, thanked the audience for their patient hearing and kind vote of thanks, and said he had some difficulty in answering directly the question put by Mr. Brown, because sometimes it was his business to sit on cases which involved the question of trawling. There was no doubt shallow waters were the nurseries for the young fish, and he hoped Mr. Brown would be satisfied with that answer.

4th December, 1894.

Mr. J. Brown read a Paper on

ELECTROLYTIC CRYSTALLIZATION OF METALS.

The metals are electrolytically deposited from aqueous solutions of their compounds, contained in little cells* provided with platinum wires for connexion to the battery. The cells are of a form suitable for the lantern microscope by which images of the crystals in the act of formation are projected on the screen. The electrolytic crystallization of metals has been studied by Dr. Gladstone and others, but I am not aware that the actual growing of the crystals has ever before been exhibited to an audience. The effect on the screen is very striking and in some cases the forms observed are very curious and beautiful.

The solutions to be operated upon contain stannous chloride, lead acetate, silver nitrate, cupric chloride and cadmium chloride; the last mentioned repeated with litmus coloration to show the evolution of chlorine as hydrochloric acid at the positive pole. The effect of this evolution of chlorine or other anion is also seen when, after the formation of a deposit of metallic crystals on one pole, the current is reversed and the chlorine attacks the metal previously deposited and dissolves it off in combining with it to re-form the chloride.

The accompanying figures from photo-micrographs illustrate two of the forms observed. In both cases *N* denotes the position of the negative pole from which the crystals grow. The crystal of tin, fig 1, forms very rapidly in a concentrated solution of the chloride under the influence of a battery of about three volts electromotive force. The rapid shooting out across the screen of the image of such a crystal or congeries of crystals is very

* I am indebted to the kindness of Mr. W. S. M'Kee for the construction of a number of these cells.

FIG I.

striking, especially when we consider the wonderful amount of accurately directed molecular activity thus suddenly called into play by the current.

FIG 2.

Fig. 2 represents the form assumed by lead deposited from its acetate by an electromotive force of about seven volts. It forms more slowly than tin. Cadmium and silver crystallize also in

arborescent forms characteristic of these metals ; copper in a more compact form.

In the experiment with cupric chloride, the bright green colour of the saturated solution helps to make apparent the phenomenon known as migration of the ions. The dilution of the solution near the cathode, due to their unequal speed of migration, causes striæ of more dilute, and therefore lighter coloured solution to ascend from this neighbourhood.

I referred above to the observed fact that while the metal is deposited at the negative pole, the chlorine or other anion of the compound is evolved at the positive pole. The question arises as to how the compound is split up so as to evolve its parts at these two distant points without either of those parts appearing in the interval between the poles. This question has been asked ever since Nicholson and Carlisle in the first year of this century discovered the decomposition of chemical compounds by the current. It has not yet received an entirely satisfactory answer.

One of the earliest explanations assumed that each metal atom had a little positive electric charge on itself, and was therefore attracted like a pith ball to the negatively charged pole, and conversely each chlorine atom had a little negative charge causing it to be attracted to the positive pole. This hypothesis seems to me to amount simply to an admission that we know little or nothing about electricity or atoms. To take an analogy, we know that an atom of tin in combining undirectedly with two atoms of chlorine evolves a definite amount of heat, but we do not, therefore, assume that this heat was previously charged on those atoms ; yet when the combination takes place in a directed way so that electricity is thereby evolved in place of heat, such electricity is, with no more apparent reason, said to have been previously charged on the atoms.

Coupled with the supposition that the atoms were charged in opposite ways, it was necessary to introduce some theory that would allow them to be freely attracted to the opposite poles. It was, therefore, assumed that a compound such as tin chloride was separated into independent tin atoms and chlorine atoms by

the mere act of solution. When we consider that the atoms of tin and chlorine appear to have a considerable mutual attraction this seems absurd, and if we take another metal with even a greater affinity for chlorine the absurdity is still more evident. One ounce of the metal aluminium, in combining with the equivalent quantity of chlorine, evolves energy sufficient to shoot a ton weight over 300 feet high in the air, that is, if all the energy could be applied to shooting tons into the air.

Are we to suppose, that when we dissolve the resulting aluminium chloride in water, the whole 300 foot-tons are temporarily annihilated and the atoms separate again to suit the impatient exigencies of modern electrolytic assumptions; or are we as an alternative to assume that, though the joining together of the atoms evolves this amount of energy, their separation may be effected without its absorption? Both hypotheses seem to me most doubtful.

Nevertheless this theory has in recent times been revised by some of the German physicists under the name of the dissociation theory. It has also been called the Williamson-Clausius hypothesis because it was stated to have been supported by these authors. In a paper published in the *Philosophical Magazine* three years ago, I showed that it was not supported by Williamson, so that this name does not apply. I have suggested another however, the neatness, comprehensiveness, and appropriateness of which, considering the German origin of the theory, will I doubt not be recognised. It is

Freidochgebundendurchcontactelectrisirtetheilmoleculishebeweglichkeit.

The theory would appear to be quite as long-winded, intricate and impossible as the name. We shall, therefore, dismiss it and turn to a much simpler hypothesis which is based on the electrolytic theory of Grotthus and is the modification of this accepted by Faraday. With that modesty which characterised the unassuming greatness of his mind he refused to follow a hypothesis, so unwarranted as that involving electrified atoms, and gently putting it aside proceeded to free himself and his writings from all danger of connexion with it by coining new electrolytic nomenclature. I regret to add that many of Faraday's

terms have been corrupted and tacked on to the very hypothesis, they were coined to avoid.

In Vol. I of his *Experimental Researches*, p. 148, § 518, he says—" Passing to the consideration of electrochemical decomposition, it appears to me that the effect is produced by an internal corpuscular action, exerted according to the direction of the electric current, and that it is due to a force either *superadded to* or *giving direction to the ordinary chemical affinity* of the bodies present. The body under decomposition may be considered as a mass of acting particles, all those which are included in the course of the electric current contributing to the final effect ; and it is because the ordinary chemical affinity is relieved, weakened, or partly neutralized by the influence of the electric current in one direction parallel to the course of the latter, and strengthened or added to in the opposite direction, that the combining particles have a tendency to pass in opposite courses." He then goes on to explain by means of a diagram, the interaction of the particles on the decomposing liquid.

With a degree less of that dignified modesty of reserve in presence of the unknown which characterized the great philosopher, I have somewhat elaborated this diagram in order to produce a mechanical lantern slide which might give a possible elucidation of the question as to how the particles of the anion cross to the anode, while those of the cation cross to the cathode without in either case appearing in the free state in the interval. The working of the slide may be illustrated by the following scheme, where in line (1) a^1, a^2, a^3, etc., represent particles of an anion, such as chlorine in combination with b^1, b^2, b^3, etc., particles of the cation such as tin. The effect of the current may now be supposed to loosen the attraction between a^1 and b^1, while it increases that between b^1 and a^2, causing an interchange of partners here, and also all along the line, resulting in the arrangement shown in line (2).

$$
\begin{array}{llllllll}
(1) & & a^1b^1, & a^2b^2, & a^3b^3, & a^4b^4, & a^5b^5 & \\
(2) & P & a^1,\ b^1a^2, & b^2a^3, & b^3a^4, & b^4a^5, & b^5 & N \\
(3) & & a^1,\ a^2b^1, & a^3b^2, & a^4b^3, & a^5b^4, & b^5 & \\
(4) & & a^1,\ a^2,\ b^1a^3, & b^2a^4, & b^3a^5,\ b^4, & b^5 & &
\end{array}
$$

In line (2), we have now, however, the *a* particles turned towards the negative pole *N*, and the *b* particles towards the positive. We therefore assume that the molecules rotate on their axes and form up as in (3), ready for a second electrolytic effect represented in (4), where we see that two particles, a^1, a^2, of the anion have now been set free at the positive pole, and two particles, b^4, b^5, of the cation at the negative pole, leaving the remainder of the substance in the same compound form as at first. A continued repetition of these processes may be supposed to constitute electrolysis of a simple binary compound in the liquid state. In the case of solutions where there are present two compounds (the solvent and the substance dissolved in it, only one of which may be undergoing electrolysis), the action is evidently more complex. Still a similar process seems possible. It must not of course be understood that the above is put forward as anything more than a working hypothesis. There is no *experimentum crucis* to prove it, but it appears to me to avoid some of the difficulties inseparable from the dissociation theory to which I have referred.

Mr. Workman—There was one point which struck me if I followed Mr. Brown correctly. The atoms of tin were free atoms, as far as the explanation went, and the red dots shown on the screen represented free atoms. Were the other atoms also free? The experiment was exceedingly beautiful, and well worthy the lecturer.

Mr. Brown—I do not quite understand Mr. Workman's difficulty. In the beginning, when the substances are all combined, there are according to the view I adopt no free atoms. What I meant by a "free atom" was an atom wandering about by itself as required by the dissociation theory. In reply to the question asked as to what cells I have used for my experiments, I may say that I am using five dry cells. I do not use all the cells for every experiment; for instance, that with tin chloride only required three. I have an arrangement for putting in circuit any number of cells I require.

A Second Paper was read by

A. S Cleaver, Esq., B.A., Entitled :—

ACROSS THE NORTH ISLAND OF NEW ZEALAND THROUGH THE HOT LAKE DISTRICT.

The Hot Lake District of New Zealand lies in the province of Auckland about one hundred and fifty miles south-east of the city of that name, and about forty-five from the port of Tauranga ; the thermal region proper includes Lakes Rotorua, Rotoiti, Rotoehu, Rotoma, Tarawera and numerous other "rotos" of smaller extent. A large tract of pumice country separates this from the Taupo district which is also volcanic and another centre of thermal activity. The line of volcanic action may be said to run almost the whole length of the North Island from the north-west to the south-east corner, roughly speaking, but at present I will speak more particularly of that part which is called "*The* Hot Lake district of New Zealand."

Leaving Auckland by train, the country we passed through did not present any features worthy of special notice, except perhaps the land had a more English look than any we had hitherto seen in the colonies, and contrasted strongly with the monotonous appearance of the Australian landscape with its forests of gum trees and large fenced paddocks covered with stumps of dead trees and fallen timber. Hedgerows and furze bushes were here common, green fields and rich corn lands lay stretched out under an azure sky, the stillness of the scene was broken every now and then by the soft notes of the lark, and but for the absence of the village scenes with the weather-beaten church and graveyard, or the white cottages of the labourers, you could easily have fancied yourself going through the Midlands of England or our own County Downon a summer's day. The railway then passed through varied scenery along the valley of

the famous Waikato river, which, once the scene of fierce fighting and campaigning, is now a prosperous agricultural district, and to use the words of another writer "cattle may be seen browsing on the land where once stood the Maori Pah and British redoubt, and Maori faces may be seen grinning a smile of cheerful recognition where they once gloated over the slain."

On the second day the *Lake of Rotorua* comes into view, and as we approached nearer and saw its outline and the distant township enveloped in clouds of steam, felt that we were at length in sight of the Wonderland of the World. At first the view of Ohinemutu, which is the native name of the township, is not impressive. Lying low near the edge of the lake on a sort of peninsula, there are no special features in its situation or surroundings to attract the eye. The lake is large and generally uninteresting, from its sides rise barren low-lying hills and the township presents a picture of the ordinary colonial township, consisting of a small cluster of low wooden houses. Nearing the lake, the first impression is of an odour which cannot be called balmy, and as we approach, it grows in intensity till the whole atmosphere seems charged with the fumes of Hydrogen Sulphide. Arriving at the Lake House Hotel, we were greeted by a curious crowd composed of Europeans, Half-castes and Maori men, women, and children to whom the arrival of the mail coach is a matter of great interest. They seemed to mix and mingle and display a genuine good feeling one to another. Their past feuds quite forgotten, they are now brethren and citizens under our own beloved Queen.

The name of Rotorua being now so well known in connection with those strange natural phenomena *the hot lakes*, and so much having been written thereon, it would be useless for me to describe in detail the wonders of the place ; but for those who have not seen for themselves or may not have read much thereon I will endeavour to sketch as briefly as possible its principal and most interesting features.

All around the shores on the land lying between the township and the lake, and beyond the township, may be seen dense

clouds of steam rising up from the earth, and on closer examination it is not difficult to find the hot springs and pools whose presence the steam betokens. These vary in size and shape from tiny steam jets playfully issuing from the sand on the shore, or from between the stones further up on the beach, to large bubbling cauldrons containing liquids in a high state of thermal activity. Here, we notice among the Ti-tree scrub stones covered with a yellowish deposit which proves to be sulphur. There, a steam cloud rises from a group of boiling springs or superheated mud holes, or perhaps we notice a basin full of the overflow water from the springs which are used by the Maori for bathing purposes. All around are evidences of the presence of a warm region at no great distance from the surface, and one cannot help treading among the scrub with a feeling of insecurity, not knowing what a false step might lead to. That there have been accidents of this sort, the neatly railed little tombstone on the promontory clearly points out. It states " that Martha Hinemoa Wilson was accidentally scalded to death in such and such a year," and indeed to a visitor such a circumstance seems to be easily within the bounds of possibility.

Some of the hot springs serve as pools for washing purposes, others are used as boilers for the village, and are of various capacities, from vast cauldrons capable of boiling a bullock to tiny pools just large enough to cook an egg. The steam issuing from the numerous fissures is utilized by the Maoris for domestic purposes, being adapted in the following manner:—Over one of these steam jets a square hole is made in the ground, just large enough to allow a wooden box with holes bored through the bottom to be set in, and by placing a board or some sacking over the top an excellent steam oven is made, which has the advantage of not requiring any attention, and from a domestic point of view is said to be equal if not superior to the artificial ones. Slabs of stone or boards are sometimes placed over warm spots on the ground where the more lazy of the natives recline and smoke, rolled in their blankets snug-warm.

Among the novelties of the scene which do not fail to attract the visitor are the *Maoris*, whose habits and customs, especially among the older ones, are very little changed with the British occupation, and no place affords such splendid opportunities of studying them as Rotorua. The native quarter of the township is separate from the European, the natives evidently preferring to live in their own simple way, rather than that of their adopted countrymen.

Their houses, or *whares* as they are called, are small huts, with sloping roofs covered with grasses, and projecting slightly in front forming a kind of verandah. They contain usually but one room, where the whole family sleep on mats of flax or blankets, and on the outside are surrounded by a rude fence, enclosing a small piece of ground, in which is grown such vegetables as sweet potatoes and pumkins so much prized by them.

Some of the *whares* of the more well-to-do are artistically carved, and above the door of almost all may be seen the grotesque little wooden figures, with distorted faces, shell eyes, projecting tongues and crossed hands, the presiding deity—the *lares* of the family.

Among the *whares* there is one building which stands out above the rest being larger and more extensively carved, having a flagpole surmounted by carved head ; this is the *Atama* or meeting house. Here they meet at regular intervals to hold council or deliberate on their own affairs, and is often the scene of a stormy debate when their tolls or lands are threatened.

The women although inferior to the men in looks are almost their equal in strength, being good workers and expert riders. They never look so happy as when strolling about the village with a baby or two strapped on their backs and a short black pipe in their mouths. Although formerly cannibal, and as shown in the native wars, bold and daring in fight, the Maoris have become tractable and harmless living on the best of terms with the *Pakeha* or white man. Indeed as you inquire more closely into their condition, and hear from themselves how

their lands have been taken from them, how the native birds and animals have been driven out by the imported ones, and how their own numbers are fast decreasing before the train of European civilization, you can at once detect a tone of despair, of sorrow for their dying race. Nevertheless the Maoris know well that their condition and status is better now than ever it has been in the past. They have four representatives in the New Zealand Parliament to whom their interest are entrusted, and if a Maori man chooses to engage in either mental or physical work of any kind, there is nothing to prevent him acquiring land, working a business or entering a profession and raising himself to a level of equality with his fellow citizen. The opportunity is always there, but alas the Maori chooses rather to pass his life in ease, enjoying all the good things of this world, and as long as he has the wherewithal to purchase gin and tobacco his highest hope is realized, his greatest ambition gratified.

Let us now turn from that which satisfies our idle curiosity to something which is of the greatest importance to the New Zealander and the world at large. I refer now to the baths whose curative properties are so well-known.

From the very earliest times since the land was settled by the present native population the Hot Springs were known by the Maoris to possess healing properties. Such was the nature of the different springs, varying from the strongest solutions capable of nearly dissolving iron to the mildest mineral water ; that the ancients living in the Hot Lake district had a bath for almost every ill their bodies were liable to. The government of New Zealand being at once alive to this fact, and knowing the value of a thermal district, purchased most of the land round Rotorua, and have now erected a splendid Sanatorium with spacious grounds for the use of invalids.

This Sanatorium and grounds form quite a feature in the otherwise barren neighbourhood. The large wooden building contrasting strongly with the small houses in the township and natives *whares* ; the grounds are beautifully laid out and planted

with numerous eucalyptus trees whose fragrance is refreshing amidst the ever present Hot Spring. Here may be seen, I think I am right in saying the only artificial geysers in the world. They are situate inside the grounds, built round with a low wall forming a sort of fountain basin, from the floor of which large pipes project, and by an ingenious method of controlling the supply of cold water (made by the engineer of the district) they are able to make the geysers play at will, and being directed up a uniform pipe, the water is thrown up in a regular column in appearance like a large fountain emitting boiling water. In another part of the grounds there is a hot pool of unknown depth, whose water is of the most transparent blue, called the "Blue pool." Looking down into it from the side, it appears like a large basin in the rock with a hole in the bottom, and as the water is just below boiling point there is no ebullition, the surface is perfectly smooth, and little or no steam rises off it. A story is told of a man with a dog visiting the pool on a very hot day. The poor animal thinking to refresh himself, at the sight of the clear blue water, plunged boldly in and perished immediately in the subtle liquid. The water is strongly impregnated with Sulphur compounds, easily detected by placing in it some article of silver such as a chain or matchbox, which is at once turned black. Unfortunately, it is not always necessary to wilfully immerse your silver jewelry to find this out, a short stay in the district will do just as much towards acquainting you with the nature of Silver Sulphide.

In appearance the water of the bath is quite milky, and the temperature about 99·7. A morning scene with men of all nationalities seriously engaged in the attempt to get rid of their bodily ailments, crowded together in the bath is a sight not easily forgotten. In the same pavilion there was also two other baths, The Madame Rachel and Blue baths, which are supplied by springs of an exactly opposite character. The water is alkaline silicious, the commonest form found in the district being used for both drinking and bathing purposes. The water is beautifully soft to the touch, and as a bath for pleasure

or luxury it would be difficult to find its equal anywhere. The peculiar softness of the water makes a gloss on the skin while bathing, and from this fact it is often called the oil bath. Froude says, he who bathes in the Rachel bath is beautiful for ever. Besides these, there are numerous other baths of muddy Sulphur water in and about the Sanatorium grounds, and all the Hotels in the township have private natural hot water baths of their own, which can be used by visitors.

Baths abound everywhere, from the small open air basin used by the Maoris, to the more comfortably enclosed ones of the Sanatorium ; and although I cannot testify as a patient to their restorative or curative properties, yet I can say, that after a long days riding, driving, or sight-seeing, I know from personal experience of nothing so invigorating or soothing as a natural Hot Water bath at Rotorua. While from the medical standpoint, the fact that the baths are patronised and visited by people of every nationality in search of health, and hundreds of cures can be vouched for by the Sanatorium doctors go far to show the value of the balneatory treatment.

Mr. Shillington—I think this Society is to be congratulated on listening to such members and friends as are not only able but willing to contribute such papers as we have heard this evening. I wish the rules of our Society allowed me to say a word or two with regard to Mr. Brown's paper ; but if we can, in passing a vote of thanks to Mr. Cleaver, allow some of our overflowings to reach Mr. Brown, we shall attain our object. An interesting thing found in connection with travel is the ability to get hold of what we see and be able to reproduce it, and I think our young townsman has completely acquired this faculty. We remember with great regret the destruction of the pink and white terraces referred to, in which catastrophe young Mr. Bainbridge, of Newcastle-on-Tyne, lost his life in such a heroic way in trying to save others. I have pleasure in moving the best thanks of this Society to Mr. Cleaver for his valuable paper.

Professor Redfern—In coming here to-night to listen to

these two papers, I knew very well what we should get from our friend Mr. Brown. I was not quite sure in the other case but I was very deeply interested, for I had previously heard a great deal from a friend who lived in that district, something of the character of these terraces, and of their sad destruction in 1886, but I had not heard what I have this evening, any such account of the way of getting to these places and the difficulties in the transit. There is not a district in the world which I have longed so much to see, and I don't think anything could have been more interesting than the details brought before us. To call them novel would be speaking of them in a most contemptuous way. I second very cordially indeed the vote of thanks to our young friend.

The PRESIDENT—I esteem it a privilege to be in the chair and in that capacity to welcome Mr. Cleaver. After what has fallen from others I cannot help saying that I have one fault to find with his paper, that it was too short. I think the vote passed by this meeting is greatly enhanced by the fact that it has been seconded ably and eloquently by a gentleman of the eminence of Dr. Redfern, a gentleman whom to know is to appreciate, and whom to appreciate is to love and admire.

Mr. CLEAVER—I am exceedingly pleased at the very courteous way in which you have received my humble effort to give you an incomplete outline of my travels in New Zealand. I feel deeply indebted for the kind and flattering manner in which Mr. Shillington and Professor Redfern have spoken of my paper. I am only sorry that time would not allow me to go into the subject in greater detail. It is one which cannot be passed over quickly ; it must be studied carefully and closely, the country is so full of interest in every respect.

Mr. YOUNG—I have great pleasure in moving that the very best thanks of this Society be given to the American Government for their contribution of valuable books ; to the Botanical Institution, of Edinburgh, for the record of their proceedings of 1893 ; and also to the Smithsonian Institute and the Nova Scotia Institute of Science.

Mr. Wright seconded the vote of thanks.

Mr. Gray—I think we should acknowledge emphatically these contributions. They are from the Government of America ; as an example to other countries, and particularly to our own. America in every department of literature, science, and art, has paid explorers, the results of their labours being sent over Europe. As I have said, it is an example which Great Britian might follow.

The President—In confirmation, I may say that the books published by the American Government giving the results of the investigations of their explorers can be obtained without difficulty by any person interested. A few years ago a friend of mine in Boston, hearing that I was interested in certain matters, volunteered to get for me some volumes published but not for sale, and I thus obtained two books of great value, which could not be had for money. The thanks of our Society will be conveyed in the usual manner.

8th January, 1895.

R. Lloyd Patterson, Esq., J.P., President, in the Chair.

William Gray, Esq., C.E., M.R.I.A., read a lecture written by John J. Marshall, Esq., entitled—

OLD BELFAST: THE ORIGIN AND PROGRESS OF THE CITY.

The President said before proceeding with the regular business of the evening he deemed it due to the memory of one lately called away from among them, Mr. Robert MacAdam, to make some allusion to him and his long and useful connection with that society. He was the last of those of whom he might speak as the old set connected with it. His elder brother, James MacAdam, a distinguished geologist, was one of the eight founders of the society in 1821, and he continued closely connected with it up to the time of his death in 1861. Robert Shipboy MacAdam was born in 1808, and was, therefore, at the time of his death last week in his eighty-seventh year. He was recorded as having attended a meeting of the society in the year it was founded (1821), nearly seventy-four years ago. He was elected an ordinary member in 1828, and a member of council in 1831, a position he continued to hold till 1889, a period of no less than fifty-eight years—an official connection with the society altogether without parallel. During that long period he filled many offices, such as those of secretary, treasurer, and vice-president, the latter office very frequently, but he repeatedly declined the presidency, a position it was long the wish of his fellow members he should occupy. Mr. MacAdam was educated at the Royal Academical Institution, and brought

up to business in Belfast. He early developed a taste for the study of Irish antiquities and archæology, and was one of the founders of the "Ulster Journal of Archæology," a valuable and useful publication, of which he believed he was editor, and to which he was a frequent contributor. Mr. MacAdam was an accomplished linguist, familiar with the classics, and with several modern languages. He was quite an enthusiastic Celtic scholar, and was particularly fond of the Irish language, literature, and music. As a near neighbour and intimate friend of his (the president's) father, he knew him all his life and appreciated his friendship very highly. Of late years he was but little seen in public. He had outlived all his old intimate friends and most of his contemporaries, so that there were now but few remaining who could recall the variety and charm of his conversation and his apparently inexhaustible stores of information. Mr. MacAdam died unmarried. He begged to move that, in recording their own regret at Mr. MacAdam's removal, the society should at the same time wish to convey to his relatives and friends their sympathy with them in their loss; and that the honorary secretary be requested to forward a copy of that resolution to Miss MacAdam.

Mr. Wm. Boyd seconded the motion, which was passed unanimously.

Mr. Robert M. Young, B.A., M.R.I.A. (honorary secretary), gave a brief description of three sepulchral urns presented to the society by Miss Watson, Killinchy, and Mr. Robert Corry, Sandown, the Knock. He said that although their Museum contained a number of fine specimens of Irish cinerary urns, it had usually happened that they were found by labourers whose first instinct was to break them in order to secure the treasure popularly supposed to be hidden in those "crocks of gold." Consequently little attention was paid to the manner of their occurrence in the soil, or even to their exact locality. The importance of a careful inspection when such excavations were either undertaken or occurred accidentally, was pointed out by Sir William Wilde in his admirable catalogue of the Royal Irish Academy.

In the case of the urns under consideration now an opportunity happily occurred of inspecting the respective localities where discovered. In May, 1893, Mr. W. Swanston, F.G.S., informed him (the honorary secretary) that an urn had been just dug up at Killinchy, and the Misses Watson, on whose land it was found, believed that another urn was still *in situ*. Accordingly, Messrs. Lavens M. Ewart and W. Swanston accompanied him to the place, and they had the great pleasure of unearthing the second urn themselves from the spot where it had been deposited many hundred years ago. By the kindness of the Misses Watson, both those urns were now in the Museum. Mr. Swanston took several photographs as the excavations proceeded, which showed its various stages. The locality was on a sloping ploughed field, 200 yards from the residence of the Misses Watson. Both urns were close together, covered by about one foot of earth. The first was inverted, and full of calcined bones, charcoal, and humus. It was broken by the spade of the labourer, who was bitterly disappointed when only "a wheen of auld banes" was found. A curiously curved bone needle, with eyelet at one end, was discovered amongst the contents of the urn. In excavating the second urn, which was erect, and filled with similar bones, care was taken to remove the adjacent soil very gently, and cord was wrapped tightly around it. Before lifting it a photograph was taken, and by leaving it untouched for some months in the hamper in which it was brought to Belfast a gradual hardening of the surface took place, which had resulted in a satisfactory specimen. Nothing was found in the surrounding soil but a few fragments of flint. The first urn measured thirteen inches in height, by twelve inches across the mouth, and was vase-shaped, with two projecting hoops dividing into three zones. The upper zone was ornamented by several panels, alternately plain and scratched with close horizontal lines. The second urn was not so coarsely made, and was ten inches high by eleven inches across the lip. It was divided into three zones, like the former, the upper or top zone being ornamented by a continuous chevron scratched in low relief.

Although the urn discovered on Mr. Robert Corry's property, at Sandown, the Knock, was about the same distance under the surface, it differed in several respects from the former specimen. It measured when whole (the rim was unfortunately broken off) fifteen inches in height by fifteen inches across the lip. This latter feature was flattened on the top, and ornamented by a series of parallel scratched lines. The lower end was only three inches in diameter, and had parallel scratched lines drawn across it. About half the height of the rim was adorned with rude flutings, rising from the foot upwards. Above these were three zones, slightly concave in section, and filled with rude zigzag lines, scratched with a stick, or perhaps a flint arrowhead. By the courtesy of Mr. Corry, Mr. L. M. Ewart and himself examined the site the day after the urn was found. It was not more than fifteen inches under the ground, was inverted, and full of calcined human bones, and rested on an ancient surface strewn with charcoal and small fragments of bone, amongst which he (the speaker) picked up a flint core and a stake. In one place a considerable deposit of charcoal occurred, resembling a primitive hearth. Mr. W. H. Patterson, M.R.I.A., informed him that he had picked up some fine chipped flint scrapers in that field. He might add that Mr. George Coffey had examined those urns recently, and would catalogue them as of unusual type in his forthcoming list. Mr. Young concluded by intimating donations—five medals commemorative of the marriage of the Duke of York and visit of King of Denmark to London, presented by the Corporation of London; sepulchral urn, found at Sandown, the Knock, presented by Mr. Robert Corry.

On the motion of Mr. W. Swanston, seconded by Mr. W. A. Ross, a hearty vote of thanks was passed to the donors.

Mr. Gray then proceeded with the lecture, of which the following is a synopsis :—In the earlier part of the middle ages Belfast, as town or city, did not exist. The Lagan, the Farset, and the Blackstaff wandered through peaceful solitudes, save where here and there a thin circle of smoke rising amongst the trees indicated a rath or fort, several of which ancient dwelling-

places existed on and around the site of the present city, of which that at Fortwilliam may be taken as an example. Many others existed which have disappeared, but M'Art's Fort still remains the most prominent object in our landscape. Such was the condition of the district undei the rule of the O'Neills, of Clandeboye, Belfast being simply a ford at low water across the Lagan, while on the narrow tongue of land between the Farset and the Blackstaff stood a small castle or fortified pile, and nearer to its extremity a chapel, wherein travellers could offer up their prayers before venturing across the ford, which could only be crossed at low water. At this time Carrickfergus was the most important place in Ulster, and long continued the superior of Belfast. In 1571 Queen Elizabeth granted the Castle of Belfast and large tracts in Down and Antrim to Sir Thomas Smith, and in 1573 the same district was re-granted to the Earl of Essex. Although neither grantee was able to carry out the conditions attached to the grant, it involved their descendants in difficulties which lasted until the succeeding reign. While English courtiers were parcelling out the country on parchment the O'Neills still governed Clandeboye from their residence of Castlereagh, until on the occasion of a grand debauch being held, Con O'Neill sent his servants to purchase wine at Belfast, they came in collision with some English soldiers stationed in the Castle; the final result of which was the downfall of the house of O'Neill of Clandeboye.

On November 5th, 1603, Sir Arthur Chichester received a grant from James I. of the whole district, and from this practically dates the founding of the city of Belfast. He erected a castle on the site of the older one, which had passed through so many vicissitudes, and in 1612 received the title of Baron of Belfast. The town had so far progressed that in 1613 it was created a Corporation, and probably at this time was granted a coat of arms. After this the little town progressed quietly and steadily until the breaking out of the rebellion in 1641, which caused considerable consternation in Belfast, with the result that the people of the town and neighbourhood erected a rampart for

its defence. The only time the rampart was destined to be used was when the Cromwellian forces, under Colonel Venables, captured the town from the Royalists in 1649, after a siege of four days. After this peace was the order of the day under both the Protectorate and the Merry Monarch ; and a sign of our growing prosperity will be found in the erection of the Long Bridge, which was commenced in 1682, to take the place of the ford. It was erected at the joint expense of the Counties of Down and Antrim, and was barely completed when the Duke of Schomberg arrived in Belfast with an army to conduct the Irish campaign for William of Orange in 1687. On the 14th June 1690 King William himself landed at Carrickfergus, and proceeded the same day to Belfast, stopping at the Castle, which had been prepared for his reception ; on his departure for Hillsborough his Majesty was overtaken by a very heavy shower of rain opposite Orangegrove, now known as Cranmore, while taking shelter under some large trees he was invited by Mr. Eccles, the proprietor, to enter his house until the shower would pass over, which he accordingly did. It is traditionally stated that the first printing press was set up in Belfast in connection with William's army.

Certainly the next most important incident in our local history was the establishment of the "Belfast News-Letter" in 1737, with which the modern history of Belfast may be said to commence. This was followed by the issue of a rival journal called "The Belfast Courant" in 1745, which, however, had but a short existence. To turn from newspapers and printing to literary men is but a step, and that step brings us to Dean Swift, who in his early days was settled near Belfast and a frequent visitor to it, while another clergyman eminent in a different direction, was John Wesley, who often preached in Belfast during the latter part of the eighteenth century. With the exception of the scare which resulted from the capture of Carrickfergus by the French, when Belfast was menaced and ordered to send provisions to the invaders, nothing of any note occurred until the commotion caused by the invasion of the

Hearts of Steel in 1770. The disturbance was of agrarian origin, and more immediately due to the arrest of David Douglas, a farmer of Templepatrick, by Waddell Cunningham, a leading citizen, on a charge of houghing some cattle belonging to Mr. Gregg. The insurgents wrecked Mr. Gregg's house, and threatened to burn the town, when through the meditation of Dr. Halliday, the prisoner was given up to them, and they retired in triumph. We now come to one of the most interesting epochs in Belfast history, the Volunteer movement, which had its origin here, and which exercised such a widespread influence upon our country. As the centre of this movement there was a review held annually, usually with the Earl of Charlemont, the Commander-in-Chief of the Volunteers, as reviewing general. The Volunteers flourished for a few years, and achieved many political reforms, after which a Republican spirit crept into their ranks and coloured their actions, which naturally caused them to be looked upon with disfavour by the authorities, and their former services were forgotten. By this time they had reached the parting of the ways, the more moderate amongst them taking the side of the Government, which only served to strengthen the sentiment of others in favour of a Republic. The consequence of this was that the Volunteers were gradually merged in the United Irishmen, which society was inaugurated in Belfast in 1791, having for its object the complete reform of Parliament and political freedom for all Irishmen without respect to their religion, and for the advocacy of these opinions the famous "Northern Star" newspaper was founded. Amongst the principal leaders of the movement in Belfast were Henry Joy M'Cracken, Samuel Nelson, Thomas Russell, and the brothers Simms, while Wolfe Tone was a frequent visitor to the town to help on the movement. Republican ideas gained ground rapidly in Belfast, with the result that in 1793, the Government issued a proclamation dissolving the Volunteers, and strengthening the garrison with a large number of troops, the whole under the command of General Lake. This vigorous action on the part of the executive had the effect of driving an

open political organisation into underground channels, the final result of which was the abortive rebellion of 1798, which owing to the precautions taken by the Government, Belfast passed through without bloodshed.

This brings to a close one of the saddest periods in Belfast history, and through the political exertions of Lord Castlereagh the 1st of January 1801 was to see the Union Jack floating over the old market house as the symbol of a new era, which was destined to be unexampled for progress and prosperity in the annals of our city. That the stormy period through which the town had passed had not materially retarded its progress was largely owing to the employment afforded by the linen industry, hand-loom weaving being practised in almost every household, while the spinning wheel, which is now but a curiosity, was then an article of furniture. With the application of steam-power machinery to the production of linen the trade was revolutionised, transferring the making of linens from the home of the weaver to the factory, as the industry is carried on to-day, leaving as a landmark of the past the old Brown Linen Hall, with its pavements and standings grass-grown and deserted, and the White Linen Hall, shortly to be taken down. Another industry which took root early in the century in Belfast was shipbuilding, a notable example being the launch of the Aurora, the first steamship built and engined in Belfast, which event took place in the year 1839. She was intended for the trade between Belfast and the Clyde, and was the pioneer of our efficient cross-channel fleet of to-day, and of the shipbuilding industry which was to develop in our days, until shipbuilding in Belfast has reached the highest point of naval architecture. Belfast was thus achieving peaceful commercial triumphs when O'Connell in furtherance of the repeal movement visited it in 1841. Dr. Cooke seized the opportunity to challenge him to a public discussion of the question, which O'Connell declined on the ground that as Dr. Cooke was the leader of the Presbyterians, to enter into a controversy with him would appear as if he was opposed to the Presbyterians, whereas in reality he was their very good friend.

The important event which created a stir in the quiet waters of our local history was the visit of her Majesty the Queen to Belfast in 1849, the town being profusely decorated in honour of the event, and the visit an unqualified success. With the march of improvement and the rapid growth of the town during recent years many interesting and historic buildings have passed away, while some still remain. One of these landmarks of the past is the old Exchange, which still stands in somewhat altered form at what was known as "the four corners," opposite Bridge Street; another was the House of Correction, which stood at the corner of Howard Street, of which only the boundary wall remains, while the Old Theatre erected in Arthur Square, in 1792, was taken down to make room for the present structure in 1871. Arthur Square itself has greatly changed during the last thirty years; indeed, to one absent for a lengthened period the town is hardly recognisable, one of the most striking improvements being the laying out of Royal Avenue on the site of Hercules Street, while the erection of the present Albert Bridge, to take the place of that which give way in September, 1886, has contributed greatly to the improvement of that part of the city. Our modern ideas of convenience and improved knowledge of sanitary laws in effecting the removal of old buildings, the widening of streets, and the clearing of congested areas has produced such a change as renders old Belfast but a memory, which antiquarian and historian may labour to preserve, but there is no reason to regret that it has been succeeded by the stately streets and modern mansions, with their many comforts, which constitute the Belfast of to-day.

On the proposition of Mr. John Malone, seconded by Mr. John Horner, votes of thanks were accorded to Messrs. Gray, Marshall, and Allen.

The meeting then concluded.

5th February, 1895.

W. SWANSTON, Esq., Vice-President, in the Chair.

DR. JOHN MACCORMAC gave a Lecture on

EDUCATION AND INNERVATION.

The Lecturer said—In his inaugural address to the students of the University of St. Andrew's, the late John Stuart Mill said of education—"Not only does it include whatever we do for ourselves, and whatever is done for us by others, for the express purpose of bringing us somewhat nearer to the perfection of our nature ; it does more ; in its largest acceptation, it comprehends even the indirect efforts produced on character and on the human faculties by things of which the purposes are quite different ; by laws, by forms of government, by the industrial arts, by modes of social life ; nay, even by physical facts not dependent on human will, by climate, soil, and local position. Whatever helps to shape the human being, to make the individual what he is, or hinder him from being what he is not, is part of his education." The development of the true man in the way most suited to his most peculiar characteristics should, therefore, be the highest and most important consideration of every man, who has the welfare of his species or country at heart, for the general problem in this broadest of all questions for solution appears to me to be presented to us in one word—namely, education. Now the function of education may be briefly stated as the preparation for complete living, and this is evidently what Mill meant when he uttered the words to which I have drawn attention. For to know in what way to

manage our affairs, in what way to treat the body, in what way to treat the mind, in what way to fulfil the duties of a parent or a citizen, in what way to utilise those sources of happiness which nature supplies ; in short, how to use all our faculties to the greatest advantage of ourselves and others, that is, how to live completely, is the true function of education. Now the development of the various activities which constitute human life may be classified under three heads—viz., Physical, Intellectual, and Moral Education, and though at different stages these three sections may be said to shade off into each other and blend together, yet the initial steps in each may be treated as distinct and clearly defined. And to understand the nature of each it is necessary to have a clear idea of the ultimate issue, towards which the necessary activities in each are tending. In physical education the special object is the functional development of all the organic aptitudes of the system. Intellectual education aims at the development and training of those faculties by which man is enabled to derive the utmost advantage from his environment, and to become himself a centre of activity in mental operations. By moral education may be understood this very broad principle, that effect follows cause, that the true consequences of conduct cannot be warded off, intensified, or ignored. How to secure the most effective system of training in order to accomplish these various objects has engaged the attention of the learned and thoughtful from the earliest times to the present day, and it must be confessed that the success achieved has not always been the highest and most complete possible. That mistakes have been made, even the greatest enthusiasts in the cause of education must admit, and my object to-night, if possible, is to put before you some considerations, to which, if due attention be paid, we may look for greater success in the future. It is unfortunately the case that the influence of the nervous system in physical, intellectual, and moral training has been either lost sight of or ignored, and so failures have had to be recorded What I wish, therefore, to set before you is the intimate relationship existing between the development of

powers, qualities, and characters, and the nervous system, or going to the root of the matter between education and innervation.

Let us consider the physical training which is necessary to promote the most favourable conditions under which these may be developed to the greatest perfection. One of the most flagrant vices of modern education is the abnormal development of the mental faculties to the exclusion of physical training, and, I think, a few moments consideration cannot fail to convince us of the great dangeı which we are incurring under this head, and how there is a possibility of our handing down a generation physically inferior to ourselves and immensely so to our predecessors. Not that I would advocate a lessening of mental culture, but with the cultivation of the mind, the proper culture of the body also, so that there may be in our children a "Mens sana in corpore sano." That this warning is not unnecessary I will give you, in support of what I have said, the substance of the remarks of an eminent scientist, Dr. Crichton Browne, on this point. In writing to "The Times" in reference to the appearance of some lady students, Girton girls, whom he saw waiting at a roadside station, he remarked on the contracted chests, high shoulders, spectacled noses, and hardened features of these young ladies, and warned the readers of that journal that excessive study might seriously detract from that personal beauty and attractiveness for which English girls were famous. Moreover, it was also pointed out that, as the consequences of excessive study unmixed with a proper amount of physical training were so serious, young ladies should hesitate seriously before they ran the risk of losing those charms which rendered them so attractive to the other sex. Now such a disaster is largely due to the fatal ignorance of what is needful for the development of the body, and to a careless disregard for the physical culture of the young. To go back to the source of this ignorance, and hence to the cause of much irreparable mischief that is produced in the constitutions of our children, how many young people, who undertake the responsi-

bility of bringing into the world those who are by and by to take their places, have the faintest idea of the duties devolving upon them? They have not the slightest conception that upon the early treatment of their offspring depends, if not the question of their life and death, at least their moral welfare or their ruin. To judge by analogy, just imagine what would be the result if an individual were to set up in business as an accountant, who had not even a smattering knowledge of arithmetic or bookkeeping; or if a man undertook to pilot a ship when he knew nothing whatever about the course of the channel, or the whereabouts of the rocks or shoals which lay hidden beneath the billows; or imagine the absurdity of a man setting up as a medical practitioner whose knowledge of anatomy or physiology was of the crudest description, or whose acquaintance with the properties of drugs was based upon the slightest and most casual observation! Truly we should wonder at this audacity and feel the utmost pity for his patients. And yet that the lives and well-being of the little ones are at the mercy of those whose knowledge of their duties and responsibilities is as a rule of the most elementary character causes neither uneasiness nor even surprise, is one of the most astonishing facts of modern experience. This point is a very important one, and deserves a whole evening for its consideration, but I can do but little more than just refer to it here. To quote the words of a very eminent educationalist—"The regimen to which children are subject is hourly telling upon them to their life-long injury or benefit, so as there are twenty ways of going wrong to one way of going right, it is not a very difficult process to form some idea of the enormous mischief done everywhere by the thoughtless, ignorant, haphazard system that prevails among us." Here again, I am afraid I must specialise a little, for since regimen is really that which determines the conditions of circulation, of waste, and of general nutrition, these in their turn act and react upon the nervous system. The various exercises contributing to these may be divided into sensory, intellectual, muscular, and affective. The

sensory are those which serve to conveniently develop and perfect the organs of sight, hearing, smell, taste, and touch; the intellectual, those which have for their aim the functional development of the organs of locomotion, of prehension and speech; the affective, those which tend to influence certain organic modifications required in the development of health, physique, and character. Now everyone knows that the sensations are so much more distinct, so much less confused, and so much more diversified as the sensory organs have been better exercised. This may be especially seen in the case of painters, in whom the organ of sight is especially trained, in musicians whose ear is taught to detect the faintest variation of tone, in handicraftsmen in whom, what has been called the great knowledge-giver, the power of touch is developed and perfected. The development of the organs of smell and taste is practically of the same character as that of touch, so that the five senses have not inaptly been termed the five gateways of knowledge. But in connection with innervation this power of touch is so important that I should like to refer you to a remark of Sir James Crichton-Browne on the "Training of the Hand." He says—"Brain motor centres are taking an indispensable share in our mental life, and mind would be as impossible without them as would be the circulation of the blood without one ventricle of the heart, and, besides this, they are constantly animating and controlling our muscular apparatus in all its intelligent applications. It is plain, then, that the highest possible functional activity of these centres is a thing to be aimed at with a view to general mental power, as well as with a view to muscular expertness, and as the hand centres hold a prominent place among the motor centres, and are in relation with an organ which, in prehension, in touch, and in a thousand different combinations of movement, adds enormously to our intellectual resources, besides enabling us to give almost unlimited expression to our thoughts and sentiments, it is plain that the highest possible functional activity of these hand centres is of paramount importance not less to mental grasp

than to industrial success." Again the cerebral functions develop with intellectual exercise as the sensory functions develop with the renewal of sensations, and just as the organs of locomotion do with the exercise of voluntary movements. At the same time, these exercises in different ways separately and collectively expend the nervous and arterial elements of nervosity. The muscular differ from the intellectual insomuch as the latter cause a more enervating waste, and one that requires for reparation more lengthened rest and sleep. Those who are habitually given to violent muscular exercises require more frequent aliment, and that of a more substantial and less delicate character than those who devote themselves to intellectual pursuits, while these ought to take food less frequently, less copiously, and that of a more juicy character than the others. It must also be borne in mind that cessation from toil is repose for the muscles, while sleep is repose for the brain. Hence the student requires a more refined diet and more sleep than the farmer. Now, to deny the suitable food or the suitable repose in either of these cases means the development of the troubles of impressionability and innervation, or, in other words, the act of nervous superexcitation, while the continued interruption of exercises results in maintaining and increasing the superexcitability of the nervous tissue in preventing the vasculonervine development necessary to the proper circulation of the blood, while the too frequent renewal or too prolonged continuance of them results in producing superexcitability in the nervous tissues by debilitating them. It must, therefore, be seen how important is the variation or alternation of the different exercises in the proper balancing of the various functions and developments of nervosity.

And now a few words on the practical application of this to modern physical training. First, I would invite you to consider how those who are interested in the breeding of various animals deal with such matters. Take the boy, and did you ever find a boy who had never in his life kept a rabbit, a pigeon, or a mouse? Take the boy, then, who spends his pennies on his

pets. He also spends his thoughts upon their proper food, mating, and rearing, and he is particularly careful that his efforts shall result in the best stock in the village. Or, take the farmer, whose hopes are centred upon his pigs, sheep, or oxen. He prides himself upon securing the best breed, in giving them the most suitable food, and in developing the best animals that find their way into the country fair. So it is with the horse trainer, dog fancier, or the poultry breeder. All aim at developing the best specimen of its kind, or in making them as profitable as possible, and in doing so they pay the utmost attention to suitable food, environment, and training. Yet with the noblest of God's creatures—man—too frequently not one of these points is seriously considered. People marry and continue the species without ever giving a serious thought to the family history on either side or the most prominent physical characteristics, and then, in due course, the children are relegated to the nursery, where their diet is administered with unvarying regularity and monotonous repetition without the smallest attention or regard to physical need, porridge and milk, or tea and bread and butter. It speaks volumes for the recuperative powers of nature that so many children condemned to such a diet survive the unnatural treatment as do. Meat, fruit, and sweets in the rapidly-developing human animal are just as necessary as the proper exercise of the limbs and lungs in the pure air of heaven. Moreover, the occasional excesses in the consumption of such food when the opportunity is afforded ought to warn parents and nurses that the wants of nature must be supplied. It is the same with clothing and exercise. Without unnecessarily covering the body with innumerable wrappings, it must be protected from a persistent sensation of cold, and for their proper development and nutrition all the muscles of the body must receive their due and regular exercise. But the consideration of this part of my subject shades off into the question of intellectual training, as I have already intimated, and bearing in mind the close relationship between them, I have now to ask you to consider the intimate

connection between intellectual education and innervation, or, to put it a little more popularly, the influence of intellectual training upon the individual through the senses. Of course, as we have seen, all training must affect the individual through the senses, for the senses are the proper portals of knowledge; they form the connecting link between mind and external influences. In the beginning of my lecture I spoke of the aim of intellectual education as the development and training of those faculties by which man is enabled to derive the utmost advantage from his environment, and to himself become a centre of activity in mental operations, and now what I want to endeavour to show is that the only true method of such training is that which tends to develop all the faculties simultaneously, that which appeals to the intellectual nature through all the channels possible. In short, what I want to enforce is, that we must cultivate in our young people observation, energy, handicraft, ingenuity, so that we may give them a pursuit as well as a study.

After long ages of blindness, men at least are seeing that the spontaneous activity of the observing faculties in children has a meaning and a use. What was once thought mere purposeless action, or play, or mischief, is now recognised as the process of acquiring knowledge on which all after-knowledge is based. Hence the properly-conceived system of object lessons, for without an accurate acquaintance with the visible and tangible properties of things, our conceptions must be erroneous, our inferences fallacious, and our operations unsuccessful. Now, the cultivation of the habit of exhaustive observation is the real secret of true knowledge. Not telling what this object is, or showing some other, for that is only to teach the result of another's observations, which is a weakening rather than a strengthening process, but encouraging the developing intellect to utilise all the sensory powers. And this development of the power of observation is really a proceeding from the simple to the complex. One impression is formed, and dealt upon, and then another and another, until these are combined and

blended, and so presently a complex idea is conceived and the mind developed, and this development, like all others, is an advance from the indefinite to the definite. In common with the rest of the organism, the brain only reaches its finished structure at maturity, and in proportion as its structure is incomplete, so its actions are wanting in precision. So it has been put "like the first movements and attempts at speech, the first perceptions are extremely vague, as from a rudimentary eye, discerning only the difference between light and darkness, the progress is to an eye that distinguishes kinds and gradations of colour and details of form with the greatest exactness, so the intellect, as a whole, and in each faculty, beginning with the rudest discriminations among objects and actions advances towards discriminations of increasing nicety and distinction. To this general law our educational course and methods must conform. So the perfection of intellectual education is the utilisation of all the senses in the acquisition of knowledge, the transmission of impressions from these portals to the central office—the brain—and, as a consequence, the broadening and deepening of the powers of the mind.

We have now to consider the connection between moral education and innervation, and as to moral education, I must ask you to understand and interpret the expression in the broadest possible way—viz., that the best way to the highest moral training is that indicated by Nature herself; and that is, that effect follows cause, and hence that the consequences of conduct cannot be ignored, intensified, or avoided. Moral education, therefore, appeals directly to the common sense or intelligence of the individual, so in the first place there is an information, conveyed by means of verbal instruction, and in the second, an appeal to the mind—the affective impressionability by means of rewards and punishments. Now, the fundamental element of an instruction consists in a commandment, a precept, and we find that there exists in man a corresponding element, which is the faculty to act or abstain from action—that is, the power to will to do, or

to refrain from doing, and this is exhibited in children of even the tenderest years. This faculty may be spoken of as the plan of activity in the individual, for without such a faculty or plan he would be the creature of external influences. But it may be that there is a specific aim towards which this plan is directed. As soon as, or whenever suitable, external influences excite those sensorial or intellectual aptitudes which direct this plan, there is immediately a corresponding action on the part of the individual. For instance, if the end of activity be patriotism, and the necessary exciting influences be at work, there will be produced the boldness and indomitable energy of the soldier, or the sagacity and controlling force of the commander ; or, if it be the pursuit of science, there will be developed the patience and the careful observation of the student ; or, if it be artistic pursuits, there will be called into active energy all the qualities which produce the painter or musician. So it was by setting before the enslaved and almost hopeless Israelites the ideas of independence and freedom, that Moses, by his extraordinary genius and commanding influence, laid the foundations of the Jewish nationality, and this, too, before they had actually acquired the promised territory, and it was a similar influence that produced a Clive, a Wellington, or a Bonaparte. To a like cause may be traced the development of a Mozart or a Beethoven, of a Sidney Cooper or a Frederick Leighton.

Education of whatever kind has for its proximate end the preparation of the individual for the duties of life, but the business of moral education is to show that the consequences of an act, whether right or wrong, must be reaped by the individual. If a child touches the hot bars of the grate a burn is the consequence, or if it pricks itself with a needle or puts its hand upon a nettle pain follows, and if either act is committed again the same result is observed ; hence the act is avoided. These phenomona can hardly be called punishments, but they are simply the beneficent checks to actions which are essentially at variance with bodily welfare—the unavoidable consequences

of the deeds which they follow. They are the lessons which Nature teaches, and, to quote the well-known line, "Si naturam ducem sequemur, nunquam aberrabimus." Here, then, is a principle laid down by Nature which should influence us in the moral education of the young. Let us take one or two simple examples. A child is naturally untidy and destructive, and it is sought to correct this bad habit. Its toys are left about the floor, or wantonly destroyed. Some would content themselves with a scolding or a slight punishment, and instruct the servant to gather up the toys or the shreds, but that does not correct the tendency. The proper course is to insist upon the correction of the habit by the opposite treatment. The labour of putting things in order is the true remedy for wilfully leaving them in disorder, and the refusal to supply a new toy in the place of that wantonly destroyed. A lad damages a schoolfellow's book, he should be compelled to replace it by a sacrifice of his pocket-money. A man beats his wife, and so manifests a want of self-control or displays a brutal tendency in his nature; he should be publicly whipped by the hangman. These methods of moral culture, by the experience of normal reactions, as divinely ordained methods, are equally applicable to the youth or adult; moreover they have the following advantages:—First, they give the rational knowledge of right and wrong conduct, which arises from personal experience of the good or bad consequences which follow; secondly, by suffering the painful effects of their own wrong acts they recognise the justice of them. The principles which affect the future life are identically the same as those to which I have drawn attention; but I must not trench on the province of those whose vocation it is to set before us our duties in respect of that life. I would, however, that they, as well as all of us, should ever consider the important part played in the development of the characteristics of the individual by nervosity—the tendency of our nature which is fostered by external influences of a like character, or checked and altered by a careful attention to those of an opposite nature. By recognising this, we consider the true value of education, and

unless it is recognised the highest function of the teacher is ignored and rendered of no avail.

ANTIQUARIAN COLLECTIONS IN ULSTER.

Mr. Milligan next addressed the meeting as follows:—Mr President, ladies, and gentlemen—Within two months from the present it is proposed that an exhibition of arts and industries shall be opened within the buildings and grounds of the White Linen Hall. Ulster has long been recognised as the home of Irish manufacturing industry, and Belfast as the place in Ulster where those industries are principally concentrated. It is not intended that exhibits should be confined to Ulster, but whilst open to exhibitors from every part of Ireland and the United Kingdom, it is hoped that Ulster will be thoroughly represented, and that samples of the leading manufactures of the province will be exhibited. The cottage industries, or home manufactures, will be represented in a fitting manner also. The Irish Industries Association, founded by the Countess of Aberdeen, has been approached on this matter, and the executive of that society at once acceded to the request, and have taken space for an exhibit illustrating the work they are doing in the congested districts of this country. In the County Donegal, with the assistance of the Congested Districts Board, they have given considerable employment to the people. They have introduced a superior class of looms for weaving home-spun in wider widths, which have a better market, and offered prizes for excellence of workmanship. The result has been a much better class of work is now turned out, which commands higher prices. One of these looms will be working during the exhibition, and the process of carding and spinning the wool will be shown as it is carried on in the cottages of Donegal. The production of Irish point and other laces will be shown, together with an exhibit of all the goods for which the Industries

Association are noted, including rich embroideries, point, guipure, Limerick, and crochet lace, and homespun tweeds.

In addition to power-loom and home industry manufacture, there will be sections devoted to the arts, paintings, sculptures, natural history, and antiquities. It is the latter two branches that appeal to the members of this association, and for which we ask your co-operation and help. Celebrated as the province of Ulster is for its shipbuilding and textile manufactures, it is also notable, from an antiquarian point of view, as being the district not alone in Ireland, but in the United Kingdom, in which the greatest number of prehistoric implements of stone, flint, and bronze have been found. In proof of this, we have only to turn back to an exhibition held under this roof in the year 1852, on the occasion of the first meeting of the British Association in Belfast. On that occasion there was gathered together such a collection of Irish antiquities from this province as has never been shown since, and probably never will again. I have before me the catalogue of that collection, which was promoted by this society, and the following is extracted from the introduction to it:—"The exhibition of Irish antiquities, now in the Belfast Museum, originated with a few members of the Belfast Natural History and Philosophical Society. Being aware of the existence of numerous interesting relics throughout the Province of Ulster, they were anxious to avail themselves of the meeting of the British Association in this town for the purpose of forming an assemblage of these in the museum, which, in conjunction with those already possessed by that institution, might enable strangers from other countries to judge for themselves of the nature and extent of our ancient civilisation. It was also believed that much curious light would be thrown by such an exhibition on various obscure portions of our own history, and an impulse given to the study of archæology and the preservation of antiquities in Ireland. Circulars were sent to all the leading noblemen and gentlemen in Ulster, as well as to some in other districts. The application was responded to in a manner most gratifying to the projectors, and creditable to

the good feeling of the contributors, many of them gentlemen altogether strangers to Belfast. The result has been the assemblage of such a collection of Irish antiquities, as has perhaps never been brought together before, and such as may hardly be seen again in one place. It comprises specimens of nearly every class of antique objects ; some of extreme rarity." The catalogue extends to 59 pages, and the exhibitors from Ulster alone numbered some 40 persons. The finest and most extensive collection was shown by Mr. John Bell, of Dungannon. There were three other exhibitors from the same town, the Countess of Ranfurly, Mr. M'Clelland, and Mr. Barton. To give a slight idea of Mr. Bell's collection I may give a few items from the catalogue as follows :—250 stone Celts, 486 flint arrow heads, 200 bronze Celts, 22 bronze swords, 22 bronze skeans, 87 bronze spear heads, 9 ancient square bells, 17 querns, 24 square methers, besides bronze cauldrons, bronze pins and fibula, smoking pipes, and the seal of Turlough Lynough O'Neill. County Monaghan was well represented by Mr. Anketell, of Anketell Grove, who showed a fine collection ; Mr. Shirley, of Carrickmacross ; Doctors M'Dowell, and Young, of Monaghan. Dr. Young, afterwards on the death of Dr. M'Dowell, secured his collection, and on the death of Dr. Young, the collection was acquired by Sir John Leslie, of Glasslough Castle, where it is at present. There are a few very interesting objects in this collection—one, the bell of Cappagh, and the other a bronze sword, with a part of the original bone handle attached. Belfast was well represented by the fine collections of Mr. Carruthers and Miss Getty, as well as by those of Canon M'Ilwaine, Dr. Bryson, Dr. Stephenson, Sir Robert Bateson, and the collection of this society. A large collection was shown by Mr. Welsh, Dromore ; Mr. Bloomfield, Castlecaulfield, County Fermanagh ; and Mr. Harvey, Malin Hall, County Donegal. Almost every county in Ulster was represented on this occasion. Nearly all these collections have been scattered since. Mr. Welsh's was acquired by the Royal Irish Academy, Mr. Bell's by the National Museum, Edinburgh. The British and other English museums were enriched by several of the others.

Irish antiquities are getting scarcer year by year, and cost a great deal more now than forty to fifty years ago. A dealer in the country will now get from ten shillings to a pound for a fine flint arrow head that could have been secured for a few pence by the earlier collectors. The Royal Society of Antiquaries has been for many years educating the people to preserve their national antiquities, and the twelve hundred odd members are now in their various districts forming small collections, so that it is now extremely difficult to form a large collection. The largest private collection in Ireland at present is that of Mr. Day of Cork, who has been an ardent collector for over 30 years. The finest articles in his collection are from Ulster, including the bronze swords and weapons found in Lough Erne, and the collection of gold ornaments found on Horn Head, County Donegal. Mr. Daly has kindly consented to place any portion of his collection at the service of the committee of the exhibition. The next largest collection is that of Mr. Knowles, of Ballymena, who has the finest collection of flint and stone implements in the United Kingdom. The Rev. Dr. Buick, of Cullybackey, and Mr. Raphael, of Galgorm, have each extensive collections, particularly in flint and stone. I am sure all these gentlemen will be willing to assist also. A committee has been formed, of which Mr. Wm. Gray is president, to get up exhibits for the antiquities and natural history sections, and as these will require to be in their places before the end of March, there is no time to lose. We now ask the assistance of this society and their friends to give their valuable aid in making the exhibition as interesting as possible, so that it will illustrate the civilisation and artistic skill of the people of this country in ages long passed away. Any one who has critically examined the shrines and croziers, the gold, silver, and bronze ornaments, the beautifully formed weapons, and the exquisitely written manuscripts of the ancient Irish must at once admit that these works were the products of a naturally artistic and civilised race. In requesting contributions for this exhibition, we do not propose to confine ourselves to early or prehistoric times, but wish to have a

collection of mediæval and later art products, as old silver, china, and furniture, particularly if it have any historic association ; also old lace and such articles as would interest and instruct the present generation.

5th March, 1895.

Joseph Wright, Esq., F.G.S., Vice-President in the Chair.

William Redfern Kelly, Esq., gave a lecture on

THE GREAT MYSTERY OF STELLAR AND PLANETARY EVOLUTION.

Mr. Redfern Kelly referred in his introductory remarks to his subject as being most subtle and far-reaching in its character, embracing as it did the origin and structure so to speak of the illimitable universe, and premised that in dealing with this abstruse question he would endeavour to confine himself to those theories which are most generally accepted by the leading astronomers and scientists of the present day as to the evolution, under divine guidance, of those myriads of suns and other innumerable worlds which everywhere surround us, from such a nebulous condition of the primordial, cosmical matter as that in which we now find it in many thousands of mysterious celestial objects, which are for the most part invisible to the human eye. One of the first questions which would naturally suggest itself in considering this complex problem would be: Have we any knowledge that there exists in the vast universe any cosmical matter, in a tenuous and diffused condition, from which the stellar or planetary bodies (which we see around us in such profusion) could be or might be evolved, and to what extent could the evolution of these heavenly bodies be explained or accounted for by the operation of any physical laws at present known to us? Long before the telescope had first brought to light the many

hidden beauties and wonders of the skies several philosophers, eminent astromoners as well, had grasped the idea that the central sun of our solar system, and those far-off stars which are the suns of other systems enormously distant from us, may have been compacted into globular bodies like our own sun and celestial planets by the gradual condensation of what were termed vapours. And these speculations have to a very great extent received what may be regarded as fairly convincing proof since the introduction of that magic tube the telescope, and in more recent years the spectroscope, as well as the photographic camera, by which means we have succeeded in piercing the depths of celestial space in every conceivable direction, and to such an extent as to bring to light hosts of mysterious cloudlike objects which astronomers have termed nebulæ. The celebrated astronomer Herschel in his extensive physical researches discovered that those nebulous masses were to be found distributed through interstellar space at astounding distances from us, many of them being buried at such remote depths as to be utterly beyond the reach of even our most powerful telescopes, by which they could (where possible to get glimpse of them) only reveal themselves to us as filmy, flimsy, non-ponderable bodies, nebulous clouds, or mists of greater or less extent, the matter of which they were composed being assumed to be a chaotic description of luminous fluid, resembling to a great extent that luminous matter which is usually driven off from comets as they approach the region of our sun. A great number of the shapeless nebulæ were found to be of truly enormous extent, and among what are known as the planetary nebulæ some were found which would fill up a space fully as great as that occupied by our own sun and his entire system of planets and satellites—in point of fact, a great spherical mass, having a diameter of upwards of six thousand millions of miles. The distances at which those nebulous masses are located in space were next considered, and it was stated that they were situated at such immense distances from us that we have never yet succeeded in measuring even the distance of the nearest of those

strange bodies. Professor Bond, of Cambridge, America, has, however, ventured to ascribe to the great nebula in the constellation Andromeda a distance eqvivalent to about sixty-five years of light travel—*i.e.*, light travelling from that far-away object would then require a period of sixty-five years to reach our earth, at the enormous velocity at which we know that light does travel through the ether of space, 186,000 miles in each second, or eleven millions of miles in one minute.

The lecturer next proceeded to discuss the celebrated nebular hypothesis of the French astronomer Laplace, which was described as being a modification of the theory of the great Sir William Herschel, and which postulated that by the known laws of gravitation, and from such a partially condensed mass of primordial matter as one of those mysterious nebulæ, an entire planetary system such as our own, with its train of subordinate satellites, could be, and most probably had been produced. This great speculation of Laplace was based mainly upon the famous nebular hypothesis formulated by the German philosopher Immanuel Kant, which provided that æons of ages ago the cosmical matter which now constitutes our stars, planets, and other heavenly bodies was in a much different condition to that in which we now find it. It was diffused everywhere throughout space, instead of being gathered together and compacted into individual bodies as at present. Centres became established, towards which the cosmical matter became attracted and separate masses of the most stupendous character were thus formed. The process was repeated in each of these masses, which were thus broken up into smaller masses, and again in the smaller masses the process was still further repeated, and thus did the German philosopher Kant account for the evolution of suns and their planets and satellites. The great nebula of the Pleiades was given as an example of the isolation and compaction of the nebulous matter into stellar bodies. Laplace's theory postulated that millions of ages ago the nucleus of an enormous mass of vapour (in fact, a stupendous nebula) embraced the entire

space occupied by our solar system, extending far beyond the orbit of the outermost known planet, Neptune. This globe of gaseous matter (assumed to be the sun and his atmosphere) was imbued into a slow rotatory motion upon its own axis in process of condensation as the mass cooled down and contracted toward the centre, and as its rotatory motion would increase the equatorial parts would bulge outward, and a ring of gaseous matter would be formed which would be cast off from the contracting central body. The nucleus would continue to contract, and another and yet another nebulous ring would be cast off, and these rings would break up and become compacted together into separate globes, which would each rotate upon its axis, and in some cases would also give off rings. The primary rings cast off as above mentioned would go to form the planets, and the secondary rings to form their satellites. It was mentioned that, as this hypothesis was formulated prior to the discovery of the great principle of the conservation of energy, and before the mechanical equivalence of heat with other forms of energy had become known to scientists, it was necessary to modify the theory of Laplace to some extent. In its main features, however, this hypothesis, duly modified, may now he said to hold the field, and it certainly constitutes the basis of all our speculations upon the subject of planetary evolution from cosmical matter. The annular, spiral, elliptical, and irregular types were concisely described. The famous nebulæ to be found in the constellations Orion and Andromeda were specially illustrated by photographs, which were taken by Dr. Roberts, F.R.S., and the locations in the heavens of these interesting objects were pointed out by the lecturer.

The lecturer next dealt with the past, present, and probable future of the central sun of our solar system, comparing it with one of the stars of the Plough, or Ursa Major (the Great Bear), a beautiful star, which he said, was in its double combination forty times greater in magnitude and intensity of brilliancy than our own sun, which in its turn was one of the myriads of stars which crowd space in every conceivable direction.

Illustrations of all the most powerful telescopes in the world, past and present, were next shown, among which were Herschel's great 40ft. telescope, the leviathan reflector of Parsonstown (Earl of Rosse's), the Paris Observatory instruments, the great Lick telescope on Mount Hamilton, California, and the great Yerkes telescope, now the largest and most powerful refractor telescope in the whole world. An example was also shown of the observatory which has recently been erected and equipped on the top of Mont Blanc, almost three miles above the level of the sea.

Mr. Jaffe—I have pleasure in asking this meeting to request the Chairman to convey our thanks to Mr. Kelly for the excellent lecture which he has given. The time and labour necessary to collect such facts as he has put before us must have been enormous; but, as our chairman has remarked, the crowded state of the house, and the close attention of the audience during the entire lecture, will repay Mr. Kelly for the trouble he has taken. He will probably excuse me if I indirectly convey our thanks to another gentleman whose name he has mentioned several times—Mr. Wilson. I am sure we all very much appreciate having seen on the screen a direct copy of a negative taken in a large telescope. There is a great difference in a lantern slide taken from a direct negative and slides made from other negatives which have been multiplied. Another point which I should like to mention is the desirability of universal time. Here we have what is known as Belfast time, and I believe very few people know what that really means. Our railways are worked according to the so-called Dublin time, and our telegraphic system by Greenwich. The western European time, as it is known, is used in Great Britain but not in Ireland; the central European time is used by Germany, Austria, Hungary, Sweden, Italy, Bosnia, Servia, and Turkey; the East European time is used by Bulgaria and Roumania. The other civilised countries, Norway, Portugal, Russia, Switzerland, and Spain are using a fixed time of their own. If the Council of this Society agree that we should petition the Government on this subject, I am sure that the

other bodies, the Corporation, the Harbour Board—in fact all the official bodies—would lend their support in endeavouring to have the English time established in Ireland. It could not be done well before May 1897, and would probably require an Act of Parliament.

Mr. YOUNG—I believe I voice the opinions of those present when I say that we have enjoyed a highly educational treat this evening. I have much pleasure in seconding Mr. Jaffe's motion that our best thanks be given to the lecturer.

Mr. KELLY—I esteem it an honour to have the opportunity of lecturing before the members of the Belfast Natural History and Philosophical Society. I am exceedingly pleased to think that my lecture has been so well appreciated. It is the first time I have given this lecture, and as our chairman has very truly said there is a considerable amount of labour connected with it, but to me it is a labour of love. With regard to the reference Mr. Jaffe made to Mr. Wilson, I have already thanked that gentleman privately, but I now take the opportunity of doing so publicly, for his kindness in presenting me with two of his lantern slides. I agree with Mr. Jaffe that universal time would be a most desirable thing. I sincerely hope the matter will be taken up by this Society and the leading public bodies with the view of bringing about the desired reform.

2nd April, 1895.

R. LLOYD PATTERSON, Esq., J.P., President of the Society, in the Chair.

JAMES WILSON, Esq., M.E., delivered a Lecture on

THE ALPS, WITH ROPE AND AXE.

MR. WILSON said the record he was giving was an original record of climbing in Switzerland, and had nothing to do with the ordinary record of what was placed before the public in regard to Switzerland. Mr. Wilson then gave his experiences of mountaineering in Switzerland, devoting a good deal of time to the description of the clothing and accoutrements necessary for the proper climbing of the mountains. The experiences related were most interesting, and were of such a character as showed the difficulties which had to be faced by anyone attempting to climb the great peaks of the Alps. The lecture was of a most interesting description, and was illustrated with a large number of views showing the principal mountains in Switzerland and incidents in connection with the climbing of the same.

At the close of the lecture PROFESSOR EVERETT expressed the thanks of the audience to Mr. Wilson for the interesting and instructive lecture to which they had listened.

Mr. WILSON briefly acknowledged the vote, and the proceedings terminated.

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